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ROENTGEN PATHOLOGY OF THE CHEST IN BATTLE CASUALTIES

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A GREAT variety of pathological conditions of the chest has been encountered in battle casualties. The most frequent lesions we have seen have been rib fractures, metallic foreign bodies, blast injury with hemorrhage into lung parenchyma, pneumohemothorax, and atelectasis, both postoperative and following pulmonary hemorrhage. Transdiaphragmatic and transmediastinal wounds have been frequent; and the multiplicity of lesions present in individual cases has repeatedly produced bizarre pathologic appearances. Because of the difficulty in examining a severely wounded soldier, and because of the complexity and multiplicity of the pathologic findings, the clinicians have depended largely upon the help of the roentgenologist, both in diagnosis and surgical judgment. A brief review of 8 selected cases follows.

CASE I. This patient, a soldier, aged nineteen, received a rifle wound of the left lower chest six days prior to admission to this hospital. The wound of entrance was 2 inches to the left of the midline at the level of the eleventh rib posteriorly. The wound of exit was in the left posterior axillary line over the ninth rib. The symptomatology consisted of moderate dyspnea somewhat relieved by upright posture, and inability to take more than small amounts of liquid without vomiting. The physical findings consisted of hyperresonance to percussion, absent breath sounds in the lower two-thirds of the left chest, and a moderate displacement of the heart to the right. The general condition was good.

A single roentgenogram of the chest showed the gas-distended stomach in the left hemithorax reaching the level of the second interspace anteriorly. The left lung was markedly compressed and a slight amount of fluid was present above the stomach. There was a rather marked shift of the mediastinum to the right. The left eleventh and twelfth ribs were fractured posteriorly. Roentgenoscopy, after administration of barium by mouth, confirmed the diagnosis of herniation of the stomach through a rent in the left diaphragm (Fig. 1). The upper border of the stomach moved paradoxically with respiration. At operation, the spleen, not visible on the roentgenogram, was also found in the left chest.

CASE II. A soldier, aged thirty-seven, was wounded by shell fragments four days prior to admission. There were two wounds of entrance and two of exit over the right lower chest, one of them being about 2 inches above

the right costal arch in the mid-clavicular line with a tab of omentum protruding. The patient had moderate dyspnea and had a constant aching pain over the right lower chest, increased on respiration. Physical examination revealed

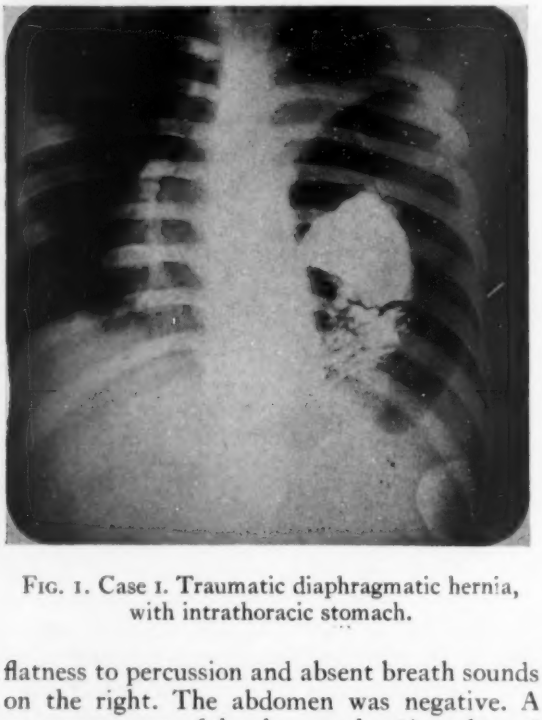

FIG. 1. Case I. Traumatic diaphragmatic hernia, with intrathoracic stomach.

flatness to percussion and absent breath sounds on the right. The abdomen was negative. A roentgenogram of the chest at that time showed a large amount of fluid within the right hemithorax compressing the right lung and displacing the mediastinum to the left. No subphrenic air could be demonstrated. Repeated thoracenteses were done and moderately bloody serofibrinous fluid was removed. On the third day of hospitalization the patient began to cough up bile which was confirmed by laboratory examination of the sputum; and a clinical diagnosis of biliary bronchial fistula was made. A chest roentgenogram at this time revealed only hydropneumothorax with multiple encapsulation. At operation there was a defect in the superior surface of the liver with a subphrenic pocket of bile walled off by the omentum. Above the diaphragm there was an encapsulated pocket of bile-stained fluid with the base of the lung adherent to the diaphragm. These two pockets of bile were communicating through a tear in the diaphragm.

Comment. This case is an example of extensive damage above the diaphragm masking subphrenic pathology. The diagnosis of biliary bronchial fistula was made on clinical findings only, and no roentgen confirmation was attempted.

CASE III. The patient, aged twenty-eight, was admitted to this hospital with a diagnosis of superficial wounds of the left leg from fragments of a hand grenade incurred the day before, and a tentative diagnosis of possible appendicitis. On admission it was noted that he had a minute wound in the tenth interspace in the midaxillary line on the left. Physical examination of the chest was negative and there was moderate generalized rigidity of the abdomen.

A roentgenogram of the chest in the upright position revealed air beneath the right diaphragm. The left diaphragm was indistinct but there was an irregular pocket of air at the left base (Fig. 2).

A perforated hollow viscus was suspected and a laparotomy was done. A moderate amount of blood was found in the abdomen, but no perforated viscus or bleeding point could be found.

The progress was uneventful until the fourth postoperative day when the patient developed

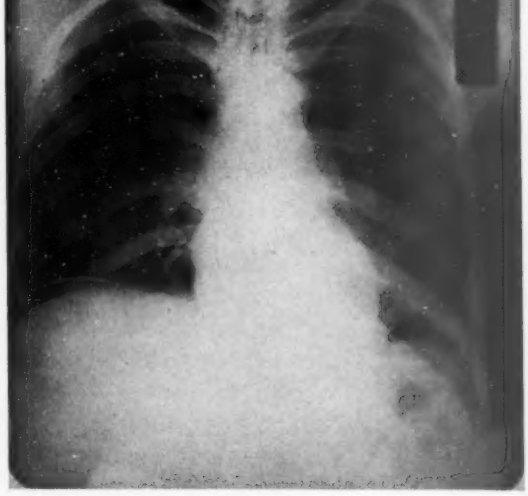

FIG. 2. Case III. Traumatic tear of left diaphragm; air beneath right diaphragm.

an atelectasis of the left lower lobe. At this time, in addition to an atelectasis of the left lower lobe, the chest roentgenogram showed a minimal left pneumothorax. Also two minute metallic foreign bodies could be seen in the left upper

quadrant of the abdomen, apparently in the spleen.

Comment. In retrospect it is believed that the metallic fragments traversed the base of the left lung and the left diaphragm, and lodged in the spleen. In the absence of perforated hollow viscus, the pneumoperitoneum was probably caused by the leakage of air from the left lung through the tear in the diaphragm. The hemoperitoneum was caused by small tears in the spleen. It is believed that an extensive pneumothorax did not develop because of pre-existing adhesions at the left base. This also accounts for the irregular pocket of air which was seen at the left base.

CASE IV. This patient, aged twenty-four, received a shrapnel wound of the left lateral chest four days prior to admission to this hospital. There was a small wound of entrance in the sixth interspace in the left mid-axillary line, and there was no wound of exit. The patient complained of some dyspnea, especially on exertion, and slight cough. He was afebrile and no precordial pain was present. A roentgenogram, taken elsewhere two days after the wound occurred, showed a normal cardiac outline and a moderate amount of fluid on the left. Although overpenetrated, this roentgenogram showed no evidence of foreign body. Physical findings indicated a left hydrothorax; the heart sounds were normal. A thoracentesis was performed and 900 cc. of bloody fluid removed. Four days later the dyspnea had increased and the patient had developed signs of fluid on the right. The heart sounds were somewhat muffled and a pericardial friction rub was elicited. A tap of the right chest yielded clear straw-colored fluid.

By that evening the patient had a moderate cardiac tamponade. A portable chest roentgenogram taken at ¾ second exposure showed enlargement of the cardiac silhouette with sharply delineated borders. There was a minimal amount of fluid in the right main pleura and a moderate hydropneumothorax on the left. A pericardial tap yielded 150 cc. of bloody fluid with definite relief of the tamponade. Two days later 400 cc. of bloody fluid was removed from the pericardium. At that time a portable chest roentgenogram again showed the pericardial fluid, and pleural fluid bilaterally, more marked on the left. A faint shadow, suspicious of a metallic foreign body, was seen in the lower left chest, and roentgenoscopy was advised. The electrocardiographic findings at this time were a prominent Q-1, elevated S-T-1 segment, and cone shaped inverted T-1.

At roentgenoscopy there was little or no pulsation of the cardiac borders. A metallic foreign body, approximately 0.5 cm. in size, was seen well inside the pericardial shadow. This fragment exhibited characteristic ventricular pulsation and did not move with respiration (Fig. 3). Kymographic studies confirmed this motion.

FIG. 3. Case IV. Foreign body in heart, pericardial hemorrhage, bilateral pleural effusion.

It was thought that the fragment was in the myocardial wall and operation was therefore performed. At operation a small area of damaged myocardium covered by a friable blood clot was found in the left ventricular wall near the apex. The foreign body could not be located. However, at closure, a metallic strip was placed outside the pericardium on a level with the lower border of the heart to serve as a radiopaque marker. Subsequent roentgen examination showed the foreign body well above the marker in a position compatible with the cavity of the left ventricle.

Comment. This case shows the inadequacy of portable examinations with long

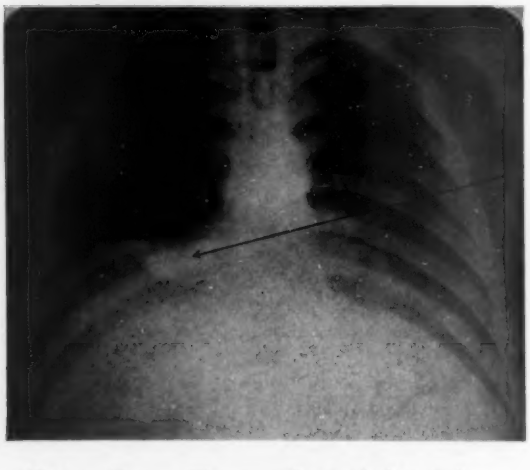

FIG. 4. Case v. Transmediastinal chest injury. Foreign body in right lung.

exposure technique. The foreign body would have been seen before if the roentgenograms had been taken with a shorter exposure time made possible by high milliamperage, using a kilovoltage sufficient to penetrate the shadow of the heart. Also the value of roentgenoscopy for foreign bodies of the chest is well illustrated. The diagnosis of pericardial effusion was made more difficult by the presence of pleural fluid bilaterally.

CASE V. The patient, aged twenty-nine, was admitted to this hospital two days after incurring a wound of the left chest caused by a shell fragment. On admission the physical examination revealed a wound of entrance in the left axilla at the level of the third interspace, but there was no wound of exit. Signs of fluid were present at both bases. The patient was moderately dyspneic on slight exertion.

Posteroanterior and lateral roentgenograms of the chest revealed subcutaneous emphysema of the left axilla. There was a moderate hydrothorax on the left. On the right side there was a more extensive hydrothorax and a minimal pneumothorax, which was encapsulated posteriorly. A large metallic foreign body, measuring 2.6 cm. in its greatest diameter, was present in the base of the right upper lobe anteriorly. There was some streaking of increased density which was interpreted as pulmonary hemorrhage surrounding the foreign body on the right and also in the left upper lung field (Fig. 4).

The foreign body was removed two weeks after the injury. At surgery, the foreign body was surrounded by only minimal inflammatory changes.

Comment. The foreign body had entered in the left axilla, traversed the left lung and the anterior mediastinum, and had lodged in the anterior portion of the right upper lobe. This case emphasizes the fact that foreign bodies can travel quite a distance in the chest and traverse the mediastinum without injuring vital organs.

CASE VI. This patient, aged twenty-two, received a "sucking" wound of the posterior right lower chest due to shell fragment six days prior to transfer to this hospital. The only symptom on admission was slight dyspnea.

A chest roentgenogram revealed a moderate hydropneumothorax on the right. A foreign body, jagged in contour and measuring 2.3 cm. in its greatest diameter, was present in the right lower chest. It was lying just anterior to the eighth rib in the mid-scapular line. An azygos lobe was present. While the rest of the right lung was considerably retracted because of the hydropneumothorax, this azygos lobe had remained in place. However, the mesoazygos was concave laterally due to the altered intrathoracic pressure (Fig. 5).

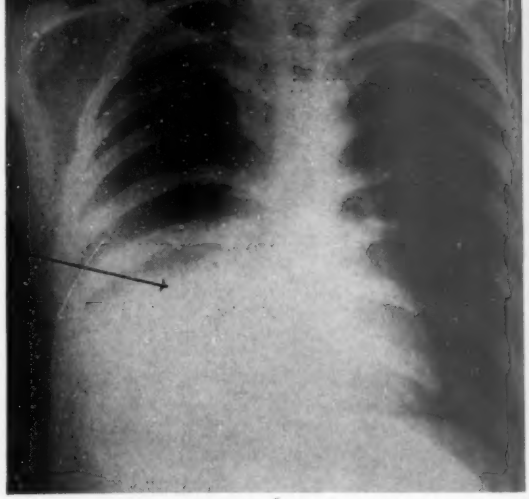

FIG. 5. Case VI. Foreign body in right lung with hydropneumothorax; azygos lobe.

The patient was treated by repeated aspirations. Subsequent roentgenograms taken ten days later showed no inflammatory reaction surrounding the foreign body, and the patient was still afebrile. There was still some residual hemopneumothorax, and this hemopneumothorax showed multiple encapsulation.

Comment. This case in one of the many cases of hydropneumothorax with foreign body recently seen. They have all shown early encapsulation of the fluid and air. This particular case was selected because of the unusual appearance of the azygos lobe.

CASE VII. This patient, aged twenty-one, received a bullet wound of the left knee four days prior to admission to this hospital. An open reduction was accomplished under pentothal anesthesia the following day. Two days prior to admission to this hospital, the patient noted the onset of a rather severe non-productive cough, and the gradual onset of substernal pain. This pain grew quite severe and was aggravated by coughing and deep inspiration. The pain spread toward the base of the neck. There was no fever, but moderate dyspnea was present. The entire respiratory episode lasted only about three days.

At the time of admission to this hospital the pain had almost disappeared and the only physical finding was a moderate subcutaneous emphysema at the base of the neck bilaterally.

A single chest roentgenogram revealed air in the supraclavicular soft tissues bilaterally and in the scaleni muscles to a lesser extent. No mediastinal emphysema could be detected and there was no pneumothorax. The heart and lungs were normal (Fig. 6).

Comment. The clinical picture is that of mediastinal emphysema with the gradual spread of the air to the base of the neck. Clinically and roentgenologically there was no evidence of pneumothorax, and the mechanism of the production of the mediastinal emphysema is probably that of rupture of alveoli bordering on a bronchus with air dissecting itself along the bronchus to the mediastinum and finally to the neck. Such mechanisms have been produced and described experimentally by Macklin, and clinically they have been described by others. Excessive cough, positive pressure anesthesia, and trauma have been the alleged causes. In this case it may have been the severe cough.

FIG. 6. Case VII. Supraclavicular subcutaneous emphysema following mediastinal emphysema.

CASE VIII. The patient, aged twenty, was struck by a truck and brought immediately to this hospital. The diagnosis was simple fracture of the shaft of the right tibia and fibula. The fractures were immediately reduced and cast applied. Shortly afterwards he noticed a sudden onset of a constrictive pain across the mid-chest accompanied by considerable dyspnea and a dry hacking cough. By the next day the same symptoms had become severe and the sputum contained moderate amounts of bright red blood. Physical examination of the chest revealed a few scattered moist râles. Roentgen examination of the chest was negative. Numerous small petechiae were noted over the trunk and conjunctiva at this time. The respiration was very shallow and painful; and at one time the respiratory rate was as high as 50 per minute. The patient was semi-stuporous. The blood nonprotein nitrogen was 55, but the urinalysis was negative. The complete blood count was within normal limits and the blood cholesterol was normal. The temperature was never above 101° F. On the following day the

patient showed considerable clinical improvement.

On the third day roentgen examination of the chest revealed innumerable small discrete areas of increased density scattered evenly throughout both lung fields. These roentgen findings were compatible with a clinical diagnosis of fat embolism (Fig. 7).

FIG. 7. Case VIII. Pulmonary fat embolism.

Three days later the patient felt perfectly well, the petechiae had disappeared and another chest roentgenogram revealed that the areas of increased density had completely disappeared.

The final diagnosis was fat embolism. Apparently the changes seen in the lungs and skin disappeared with the passage of the fat through the pulmonary and cutaneous capillaries. This must have occurred while the pathologic changes described were still reversible.

SUMMARY

1. Eight cases have been selected from a large number of chest injuries recently seen. These have been presented to illustrate the variety and type of pathological conditions of the chest seen in battle casualties. Two cases, one of pulmonary fat embolism and one of mediastinal emphysema, were included although there were complications of injury elsewhere.

2. Because of the frequency of transdiaphragmatic wounds, it is preferable to examine the patient with a chest injury in upright position. If this is impossible the patient should be examined with a postero-anterior projection in the lateral recumbent position in order to detect subphrenic air.

3. Examinations of the chest using the portable unit and routine chest technique are often unsatisfactory because the foreign bodies are difficult to see beneath the diaphragm or behind the heart. For this reason we have often used overpenetrated roentgenograms. Roentgenoscopy has given valuable information in many instances.

4. The hemopneumothorax which accompanies chest injuries becomes encapsulated early due to the large amount of fibrin present. In several cases this encapsulation took place in the paramediastinal pleura and made the differential diagnosis between mediastinal pleural effusion and pericardial effusion difficult.

5. Although some of the foreign bodies have been large and carried in bits of clothing, and although some of the injuries have been severe, we have seen no roentgen evidence of infectious processes such as empyema, lung abscess, or mediastinitis. This is attributed to the early use of penicillin and chemotherapy.

PNEUMOMEDIASTINUM IN THE NEWBORN*

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ALTHOUGH the previously reported cases of pneumomediastinum in the literature are relatively few, the experimental work of Fisher and Macklin,[8] together with the recent description of the condition in the adult, have tended to reemphasize the syndrome. Guillot[6] in 1853 reported 2 cases of mediastinal emphysema in the newborn which were recognized at postmortem examination. Following Stransky's[25] review of the literature in 1928, Gumbiner and Cutler,[5] in addition to publishing observations on several cases of their own, were able to collect 8 cases from the previous reviews. Case reports by Schuler,[21] Kirchgessner,[13] Faber,[3] Poeck[19] and Rosenblum[20] can also be found. More recent case studies by DeCosta[2] and Fisher,[7] were published in 1940 and in 1941. Smith and Bowser[22] reported 2 additional cases in 1942.

The series of cases reported by Hamman[10] in 1937 and 1939 did much to focus attention upon this condition and emphasize the associated clinical features. In the case report by Morey and Sosman[18], the roentgen and clinical features of pneumomediastinum associated with a left spontaneous pneumothorax in an adult were presented. Graebner[4] reported 3 cases of pneumomediastinum associated with acute obstructive laryngitis. This observer contended that the occurrence of air in the mediastinum was directly influenced by the obstruction of the respiratory tract and was not due to the tracheotomy which was performed. Extrapulmonic air quickly disappeared after its continued extravasation was halted by eliminating the obstruction in the respiratory tract. In the series of cases of acute laryngeal obstruction presented by Michels,[17] pneumomediastinum associated with pneumothorax was reported following the tracheotomy. Cases of mediastinal emphysema and pneumothorax following tracheotomy have also been reported by Forbes and Salmon.[9] Stenbuck[23] has also recorded 2 cases of primary mediastinal emphysema following severe crushing injuries of the entire chest.

The fact that pneumomediastinum is not more frequently mentioned does not mean that it is not recognized. The failure to record cases, however, gives the impression that the condition is rare. Speculation concerning the rôle played by pneumomediastinum in relationship to production of types of pneumothorax is interesting. Davis and Stevens[1] in 1930 reported an incidence of 6 cases of pneumothorax in the routine roentgenographic examination of 702 consecutive newborn infants. If pneumomediastinum precedes pneumothorax in such cases, an incidence of mediastinal emphysema of more than 1 per cent might be expected, since not all cases of air in the mediastinum will produce pneumothorax. In several cases reported by Hamman, pneumothorax probably produced by the escape of air from the mediastinum accompanied the interstitial and mediastinal emphysema. Graebner[4] reports a case in a six month old tuberculous infant in whom a pneumomediastinum developed. Following the increase in the amount of mediastinal air, a spontaneous pneumothorax was noted. The report by Fisher and Macklin[8] concerns a fatal result in a child of twenty months of age following aspiration of peanut kernels. Pulmonic perivascular emphysema of the left lung with the presence of large air bubbles in the anterior and superior mediastinum was found. Compression and obstruction by the emphysema of the pulmonary and mediastinal circulation resulting in severe dyspnea, cyanosis, anoxemia and impairment of the heart action produced death. It is important to stress Macklin's statement that although he was

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able experimentally to force air from the mediastinum into the pleural spaces, no air could be introduced into the mediastinum from the pleural cavities. Nevertheless, the occurrence of pneumomediastinum following the initiation of an artificial pneumothorax has also been noted.[16]

In seeking the cause of the presence of any abnormal collection of air within the

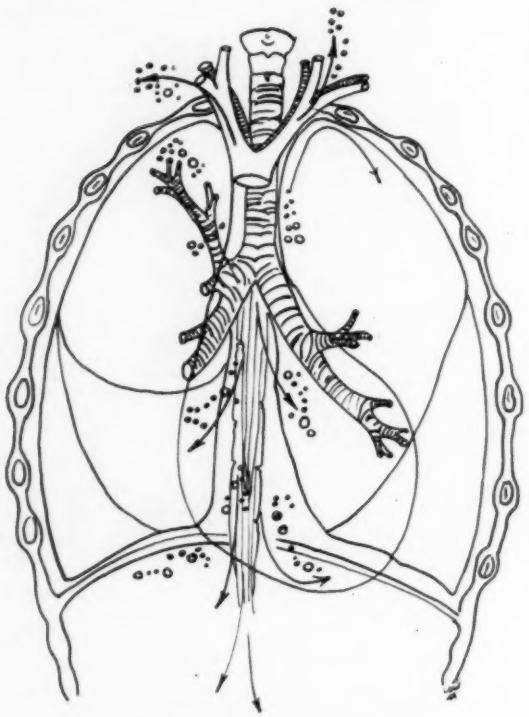

FIG. 1. Diagram demonstrating the direction of the spread of air. Pneumothorax results if rupture of the mediastinal pleura occurs. Pneumoperitoneum occurs following rupture of the peritoneum.

infant thorax, certain factors must be kept in mind. Among the variety of conditions apparently associated with mediastinal emphysema are those producing violent respiratory effects such as obstetrical labor, pertussis and obstructive tracheobronchitis. The factor of overdistention is important in those cases of intracranial hemorrhage, congenital heart disease, atelectasis with areas of compensatory emphysema where obstruction in the tracheobronchial tree is present. Macklin's work on experimental animals has demonstrated conclusively that spontaneous pneumomediastinum results from pulmonary alveolar rupture. This investigator showed that artificial overdistention of a portion of the lung produced alveolar rupture with the passage of air along the vascular sheaths to the mediastinum. Any process tending to produce overdistention of the lung could also produce a pneumomediastinum. Weakening of the walls of the respiratory tract by a pathologic process so as to produce a break in the continuity of the walls may lead to the appearance of air outside of the normal pathways. Here such factors as congenital deformities of the respiratory system, local trauma or a pulmonary infectious process are to be considered. A definite predisposing factor would be the delicacy of the lung structure of the newborn infant, especially in the premature infant. Van Allen[26] and his associates have shown that the normally collapsed alveolar spaces may open under pressure to permit passage of air between adjacent alveoli, that similar spaces under pressure will permit air to escape into the surrounding connective tissues following the perivascular sheaths until the loose aerolar tissues of the mediastinum have been reached. Once mediastinal emphysema has occurred, numerous phenomena may follow (Fig. 1). Rupture of the mediastinal blebs into the pleural cavities may produce unilateral or bilateral pneumothorax. The extension of the compressed air along the great vessels into the cervical or the axillary areolar spaces or downwards into the retroperitoneal region may occur. Extension of the air along the blood vessels to the groins to produce subcutaneous emphysema in this region may also result. Pneumoperitoneum in such cases has been reported by DeCosta and Strongin. The experimental studies by DeCosta[2] demonstrated that increased pulmonic pressures as low as 18 to 20 millimeters of mercury were sufficient to produce a bullous mediastinal emphysema in dogs which later showed no evidence of lung damage. With application of increased pressures of 60 to 90 mm. of mer-

cury, the experimental animals often died suddenly of cardiac failure. Postmortem examination in such instances revealed in addition to the mediastinal emphysema, the presence of air emboli throughout the entire vascular system. Lindbloom has actually demonstrated air in the circulatory system of newborn infants who failed to respond to strenuously applied artificial respiration. In the cases where the air remains enclosed with the mediastinum under increased tension, various actions may occur. Because of the elastic and easily compressed walls, the pulmonary and systemic veins are first affected so that the return flow of blood to the right and left auricles is diminished. The resultant congestion in the peripheral veins in the lungs occurs early and causes dyspnea.

No symptoms are evident until the intramediastinal pressure reaches zero, but as soon as a positive pressure is noted rapid changes occur. Mediastinal emphysema occurring during the first few days of life is usually manifested by respiratory and circulatory distress. Rapid and shallow respirations are noted and, in association with this, dyspnea and cyanosis may be found. Bulging of the precordium, distention of the neck veins and a fall in the blood pressure are noted. These signs are dependent upon the blockage of the circulation brought about by compression of the systemic and pulmonary veins. Distention of the peripheral veins is most usually seen in the neck. Because of the downward and posterior displacement of the heart, its tones are distant and the percussion note over the heart is tympanitic. The air surrounding the heart may produce a peculiar crackling sound, synchronous with the systolic contraction. This latter finding in association with precordial pain has been an outstanding complaint in the adult cases. Complicating conditions such as pulmonary interstitial emphysema are difficult to diagnose clinically, and roentgenographic confirmation is necessary. In cases of mediastinal emphysema, pneumothorax may not necessarily be one of the associated findings. Should pneumothorax be found, an alleviation of the symptoms may be noted probably due to the lowered tension in the mediastinum. Macklin has suggested artificial pneumothorax as a therapeutic procedure in mediastinal emphysema because collapse of the lung would tend to arrest the train of events increasing the collection of air in the mediastinum.

The diagnosis of pneumomediastinum is essentially a roentgen procedure although the condition may be suspected clinically. All cases of dyspnea and cyanosis in the newborn infant are routinely examined by means of frontal and lateral views as well as by means of roentgenoscopic examination. In the frontal view, air outlining the lateral margins of the superior mediastinum may occasionally be seen. Although some authors have stressed the lateral projection as offering the most conclusive evidence, it is seen that in several cases which are shown, air could be adequately visualized in the frontal views. In the lateral view, marked bulging of the precordium with the large area of encapsulated air immediately posterior to the shadow of the sternum is characteristic of pneumomediastinum. It is to be remembered that a marked pneumothorax may complicate a pneumomediastinum. With collapse of the elastic lung, much of the air in the mediastinum may thus be removed. For this reason, the roentgen studies in the frontal views may not be conclusive. Air in the pleural spaces may interefere and even obscure the mediastinal emphysema.

Jessup[12] considered the treatment of such cases from two aspects: control of the source of air and the production of an outlet to the air already accumulated. The treatment in all of our cases has been conservative, oxygen and stimulants being administered as was found necessary. Although the routine measures were employed in the first case, aspiration of the air was suggested by the consulting pediatrician. The child died before this procedure could be completed. The subsequent cases did not require therapeutic decompression. As-

FIG. 2. Case 1. Frontal examination of the chest made immediately following delivery shows no evidence of air in the pleural spaces.

piration of the mediastinum should be attempted only in the infants who fail to respond to the conservative measures described. While aspiration of air for the relief of massive mediastinal emphysema is definitely indicated and may be a life saving procedure, it may also fail to produce any favorable reaction because of pocketing of air in the loose connective tissues.[9]

With these features in mind, the cases of spontaneous pneumothorax in the newborn infant are reported.

CASE 1. Infant I., a girl, was born on November 17, 1940, weighing 4 pounds and 12 ounces. The child was delivered by caesarean section. Although the general condition was described as fair, the cry was feeble, associated with respiratory grunting and retraction of the lower part of the sternum. Artificial respiration was administered by means of manual compression of the breathing bag followed by relaxation. Moderate cyanosis of the child was noted which continued although the patient was placed in an oxygen tent. Complete suppression of the breath sounds was present in the right chest. The heart sounds at this time were described as within normal limits.

Roentgenographic studies by Dr. W. G. H. Dobbs at this time demonstrated no evidence of air in the pleural spaces. In lateral views, obliteration of the anterosuperior mediastinum was suggested. It could not be determined whether enlargement of the thymus or the cardiac shadow was present (Fig. 2). Roentgen examination was repeated at 3:00 P.M. on October 18, 1940, and the features shown in Figure 3 were noted. A collection of air in the anterior mediastinum outlining an enlarged heart shadow and the thymus was noted. The thymus did

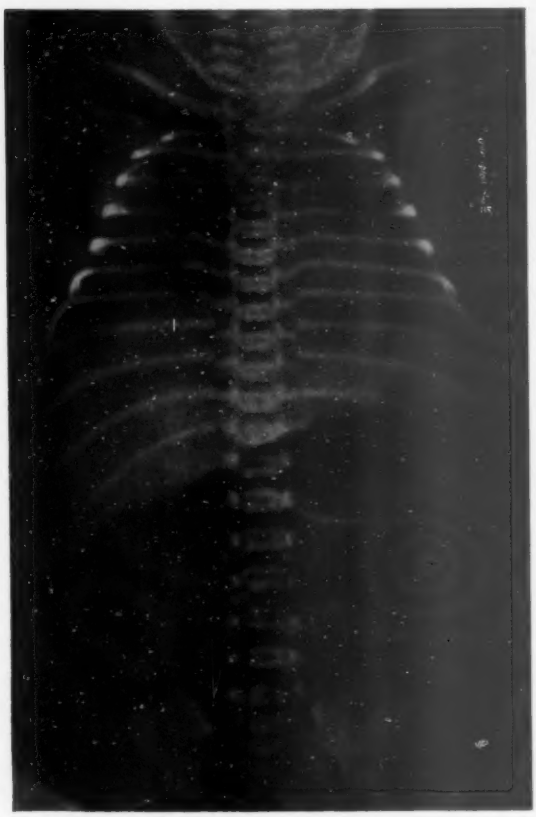

FIG. 3. Case 1. The re-examination in the frontal projection demonstrates a large collection of air in the anterior mediastinum outlining an enlarged heart shadow and the thymus. Bilateral pneumothorax is present.

not appear enlarged. A thin line of air overlying the margin of the right diaphragm can be seen. In the lateral view (Fig. 4), the thorax shows marked anterior bulging and immediately posterior to the sternum, a large collection of air can be seen. The lower esophagus is filled with air. Following ingestion of a small amount of barium, the lower esophagus and stomach were shown and found negative.

Following roentgen examination, the child become markedly cyanotic, and respirations stopped but the child was revived by means of artificial respiration. The child was seen by a pediatrician who suggested immediate mediastinal aspiration. Death occurred before this procedure could be completed.

An autopsy done immediately showed the marked bulging of the anterior chest which had been previously described. Both lungs were collapsed against the mediastinum which was present in the midline. No air could be found in the subcutaneous or the retroperitoneal tissues. No tears were visible in the mediastinal or the visceral pleura. The pleural domes were cautiously examined and no tears could be found in this region. The tracheobronchial tree was patent throughout. Microscopically, the lungs showed areas in which the alveolar outlines were not recognizable and there was considerable atelectasis. The myocardium was normal microscopically.

The marked mediastinal emphysema and bilateral tension pneumothorax which can be seen adequately in the accompanying roentgenograms produced marked respiratory and circulatory difficulties resulting in death. Previous observers have already noted that when pneumomediastinum is accompanied by a tension pneumothorax, the probability of a fatal outcome is definitely increased. It is unfortunate that mediastinal aspiration which was recommended by the pediatrician in charge was not completed.

Fig. 4. Case 1. The lateral view demonstrates the marked anterior bulging of the sternum. The encapsulated air in the anterior mediastinum behind the posterior surface manubrium and the body of the sternum are shown. Because of the increased mediastinal pressure, the heart and superior mediastinal structures are displaced posteriorly. Air overlying the right diaphragm in the frontal and lateral views can be seen.

Case II. Infant C., a girl, was born on July 26, 1943, at 7:12 A.M., weighing 4 pounds and 13 ounces. The infant was delivered spontaneously of a thirty year old white gravida III. The cry was spontaneous but weak, the color was poor and respiration was labored. Artificial respiration was attempted by means of 5 per cent carbon dioxide and 95 per cent oxygen. Tenacious mucus in the throat and nostrils was removed by intratracheal suction. Some improvement in respiration was noted. However, slight cyanosis was noted at this time. Physical examination showed marked suppression of the breath sounds on the left with obliteration of the cardiac dullness. No distention of the neck veins was seen. There was no bulging of the precordium and no subcutaneous emphysema could be palpated. The child was placed in a Hess oxygen bed, given stimulants, and immediate roentgenographic examination was made.

The examination in the frontal position (Fig. 5) showed depression of the domes of the diaphragms. No paravertebral translucent areas could be seen. There was no increase in the width of the cardiac silhouette. Although dimin-

Fig. 5. Case II. No paravertebral translucent areas are seen. No increase in the width of the cardiac silhouette is shown. From this frontal view alone, a diagnosis of mediastinal emphysema cannot be made. (Contrast this projection with Fig. 3.)

ished aeration of the entire right lung was noted, emphysema of the left base could be seen. In the lateral view (Fig. 6), the sharply delineated translucent shadow of the encapsulated area in the anterior mediastinal region immediately posterior to the posterior margin of the manubrium and the body of the sternum could be seen with posterior displacement of the heart and mediastinal structures. With the diagnosis of pneumomediastinum thus established, the patient was returned to the oxygen tent. The child's respirations were noted as normal on the following day and no evidence of cyanosis was demonstrated. The air gradually disappeared from the anterior mediastinum over a period of three days and no recurrence of the pneumomediastinum has been noted. Roentgen studies were made on July 28, 1943 (Fig. 7) and on July 29 (Fig. 8).

Case III. Infant E., a boy, was born on August 10, 1943, at 3:21 P.M. The delivery was spontaneous of a twenty-seven year old white primipara. The general condition at birth was extremely poor, the color was moderately cyanotic and respirations labored. The child was given artificial respiration and 5 per cent carbon dioxide and 95 per cent oxygen inhalations. The examining pediatrician thought that a left-sided atelectasis with bronchopneumonia could account for the appearance of the infant. The roentgenographic examination on August 12,

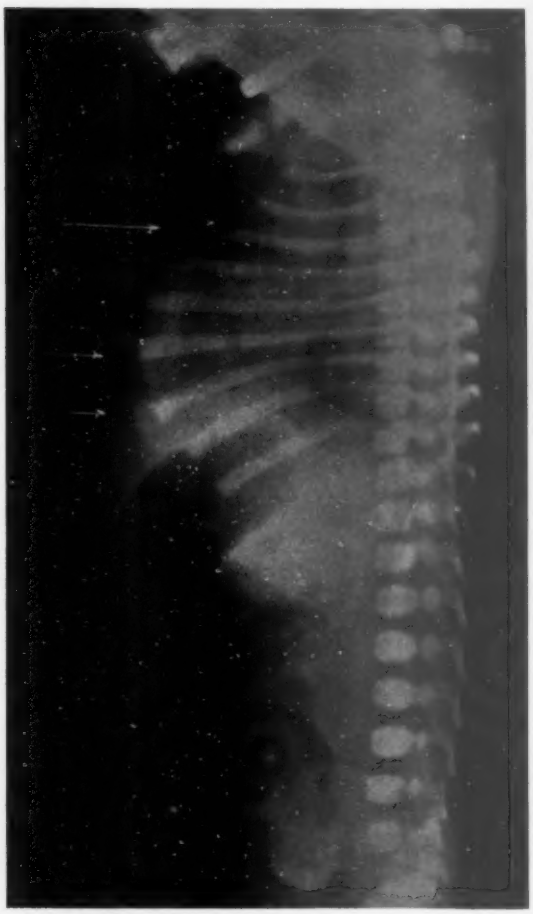

Fig. 6. Case II. Lateral projection demonstrates the sharply delineated encapsulated air in the anterior mediastinum. No displacement of the mediastinal structures is shown. No bulging of the precordium is seen here as in the first case. The marked importance of a lateral view is demonstrated.

1943, showed no evidence of atelectasis or displacement of the cardiac structures. A diagnosis of pneumomediastinum was established. Again conservative treatment was resorted to and the child was kept in an oxygen tent continuously. On August 14, 1943, roentgenographic examination showed no evidence of air in the mediastinum. No recurrence of the cyanosis or respiratory difficulty was noted and the infant was discharged from the hospital on August 24, 1943.

Thus stressing the effects of increased intrapulmonic pressures, it is interesting to consider the rôle that artificial respiration might play in the formation of pneumomediastinum. Each of the infants in the reported cases received some form of artificial respiration. In Cases II and III, the manual compression of the breathing bag in the attempts to insufflate the lungs was described as being moderately vigorous. We have noted a case of pneumomediastinum and subcutaneous cervical emphysema in a seven year old boy following intratracheal catheterization and the application of artificial respiration. It must be remembered, however, that symptoms of respiratory difficulty were pronounced and that artificial respiration was resorted to in order to relieve the embarrassed breathing. It is difficult to determine in these cases whether the presence of the pneumomediastinum necessitated some form of artificial respiration or whether the attempted resuscitation

FIG. 7. Case II. Lateral projection thirty-six hours later showing a reduction in the amount of air in the anterior mediastinum.

FIG. 8. Case II. Lateral projection demonstrating complete disappearance of the pneumomediastinum.

produced the air in the mediastinum. It is of significance that all of the cases received some form of artificial respiration and attempted insufflation of the lungs. That such methods are hazardous and should be administered by well trained individuals has been repeatedly stressed.*

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* Since June, 1944, three additional cases of pneumomediastinum have been observed.

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ECHINOCOCCUS CYST OF THE HEART*

REPORT OF A CASE

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INTRODUCTION

ECHINOCOCCUS cyst of the heart is rare. Only 4 cases have been reported previously in American medical literature, 3 at autopsy and 1 in a living patient. Grulee[7] was the first to report a case of echinococcus cyst of the heart in 1905 in an Italian immigrant girl who coughed up cyst material and died suddenly five days later. Autopsy revealed a hydatid cyst the size of a pigeon's egg which had ruptured into the auricular chamber from the posterior wall. The lungs were full of small hydatid cysts. Davis and Balboni,[3] in 1917, reported the autopsy finding of echinococcus cyst of the heart associated with cysts of the brain and lumbar spinal cord. Mills,[10] in 1922, reported an autopsy on a thirty-six year old female in whom an echinococcus cyst 4 by 5 cm. in size was found at the apex of the right ventricle. He stated that no case of echinococcus cyst of the heart had ever been diagnosed in a living subject. In 1941, Atwood, Sargent and Taylor[1] reported an echinococcus cyst of the left ventricle in a living patient, an elderly white female, a native American residing in California. Both intradermal and complement fixation tests were negative.

As nearly as can be determined, 159 cases of echinococcus cyst of the heart have been reported to date in foreign literature. The first significant paper on the subject was by Griesinger[6] (1846) who reported 15 cases found at autopsy. In 1905 Grulee[7] collected 55 cases from the literature including those of Griesinger. These cases ranged in age from seven to seventy-three years, 41 per cent being between fifteen and twenty-five years of age.

In 1928 Dévé[4] gathered and analyzed 137 authentic cases of echinococcus cyst of the heart. The heart was the only organ involved in 82 per cent of the cases and left-sided cysts were more common than right. Of 90 ruptured cardiac cysts, 20 ruptured into the pericardium, 38 into the right side of the heart and 32 into the left side. In Dévé's opinion, echinococcus cyst occurring in the heart is always primary. The last case reported in foreign literature was that of Fernandez Saralegui[5] of Argentina in 1941.

CRITERIA FOR DIAGNOSIS IN THE ABSENCE OF AUTOPSY

The clinical diagnosis of echinococcus cyst of the heart is difficult because symptoms and signs are often absent, and if present, simulate other diseases. Echinococcus infestation usually occurs in childhood. The cyst may remain latent for many years. Symptoms and signs, when they arise, are usually due to three causes, namely: pressure of a growing cyst on the myocardium, or the acute allergic reaction to the escape of antigenic fluid from a ruptured cyst, or to the development of secondary cysts from metastasis of hydatid sand to adjacent or distant tissues and organs.

The roentgenologic observation of a rounded mass surrounded by a ring of calcification is of the greatest diagnostic importance. Blondau *et al.*[2] emphasize the heavy ring of calcification in the cardiac echinococcus cyst as almost pathognomonic

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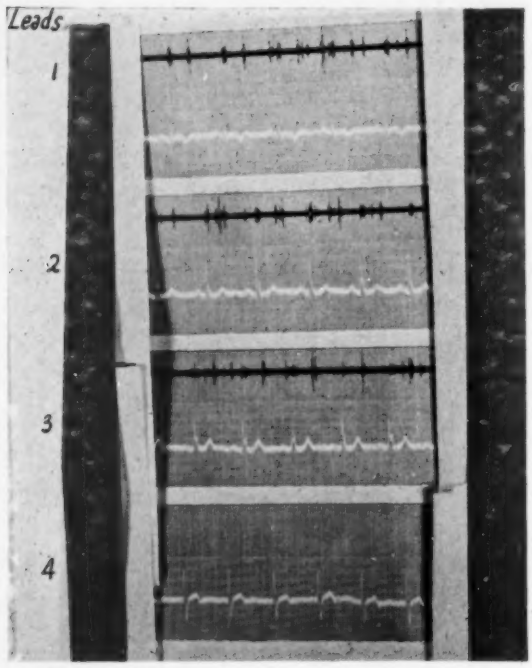

FIG. 1. Electrocardiogram and stethogram.

of cardiac rather than pulmonary cysts. The electrocardiographic findings are nonspecific, being those of myocardial change or conduction defects.

Eosinophilia is present in 50 per cent of cases with active hydatid disease. The finding of hooklets, scolices or cyst fluid at operation, or during laboratory examination of the excreta or body fluids, is specific evidence of infestation by echinococcus granulosus. Immunologic tests with echinococcus antigen such as the intradermal, the precipitin and the complement fixation tests are positive in 87 per cent of cases with active disease. These tests are group specific, not species specific. Positive reactions have been obtained with antigen prepared from cestodes other than the echinococcus granulosus.[11] The stools must therefore be examined carefully for the presence or absence of other types of cestode infestation, such as *Taenia solium* and *Taenia saginata*, before the true evaluation of a positive test with echinococcus antigen is possible.

Immunologic tests may be negative if the echinococcus cyst either has been cured, or if its contents have become caseous and inert. In such a degenerative state, reagin may not be formed and immunologic tests may become negative.

CASE REPORT

The initial evidence leading to the discovery of a case of echinococcus cyst of the heart was found during the routine 35 mm. photofluorographic chest examination of recruits at the Sheepshead Bay Maritime Training Station, Brooklyn, New York. The 35 mm. film was reported as a cystic tumor in the heart or lungs. A confirmatory 14×17 inch posteroanterior roentgenogram revealed a rounded cystic tumor the size of a silver dollar with a ring of calcification at its periphery overlying the cardiac apex and adjacent lung. The patient was referred to the Station Hospital for further study.

C. T. R., a native American, white, male, aged twenty-eight, had considered himself in excellent health. He had always lived in the United States, from his sixth to ninth years in Florida, and the rest of his life in Connecticut. He is married, has one child, and for the past five years had worked as a bus driver. Since the age of ten, he has had "pet dogs." In his boyhood, his dog frequently shared his bed. He gives no history of urticaria, precordial pain, or cardiac decompensation, and has never had to limit his physical activities. His mother, aged fifty-seven, has been troubled with tapeworm disease for the last twelve years. She owns dogs, and the patient has been accustomed to petting and handling them.

Physical examination failed to reveal evidence of organic disease. The patient was a robust white male, weight 180 lb., height 5 feet 9 inches. The lungs were clear and the heart was normal. The apex beat was in the fifth interspace within the mid-clavicular line. The heart tones were of good quality. There were no murmurs or thrills. Heart and pulse rate were 72 per minute. The rhythm was regular and his blood pressure was 122/80. Abdominal examination failed to reveal enlargement of the liver, spleen, or kidneys.

Laboratory Data. The urine, sputum and feces examinations were negative. No evidence of tapeworm infestation was found.

Blood count revealed red blood cells to be 4,785,000. Hemoglobin was 16.2 gm. per 100 cc.; white blood cells were 8,200, with a differential of lymphocytes 34 per cent, polymorphonuclear leukocytes 66 per cent, and eosinophils 0.

The electrocardiogram revealed an inverted T1—coronary type, W-shaped Q-R-S 1, splintered Q-R-S2 and 3. This was interpreted as evidence of myocardial involvement (Fig. 1).

Intradermal test using 0.1 cc. of human echinococcus antigen obtained from the National Institute of Health at Bethesda, Maryland, was positive. An itching wheal appeared within five minutes after injection and reached a diameter of 2.5 cm. at the end of twenty minutes. Control inoculations with physiological saline were negative. Intradermal inoculations of the same echinococcus antigen in 10 normal individuals gave negative results. The echinococcus complement fixation test was negative. The precipitin test was not done. Blood Kahn and Wassermann tests were negative. Intradermal tuberculin test was negative.

Roentgenographic and roentgenoscopic examination of the chest revealed both lungs to be well aerated. The left diaphragm was tented by an adhesion in its midportion. The heart was in the midline. Its transverse diameter measured 16 cm. as compared to the internal transverse chest diameter of 35 cm. Bulging from the left ventricular wall 2 cm. above the cardiac apex on the posteroanterior view was a 4 by 5 cm. cystic tumor delimited at its periphery by a ring of calcification. It possessed a vigorous non-expansile beat synchronous with the cardiac pulsation and did not move with respiration. On the left lateral view the cyst overlay the left ventricle 2.5 cm. posterior to the location of the interventricular septum just inferior to the auriculoventricular groove. Posteroanterior, left and right anterior oblique views of the heart with barium in the esophagus, failed to reveal evidence of chamber enlargement (Fig. 2 and 3).

Fig. 2. Posteroanterior view, 6 foot chest roentgenogram. Echinococcus cyst of heart.

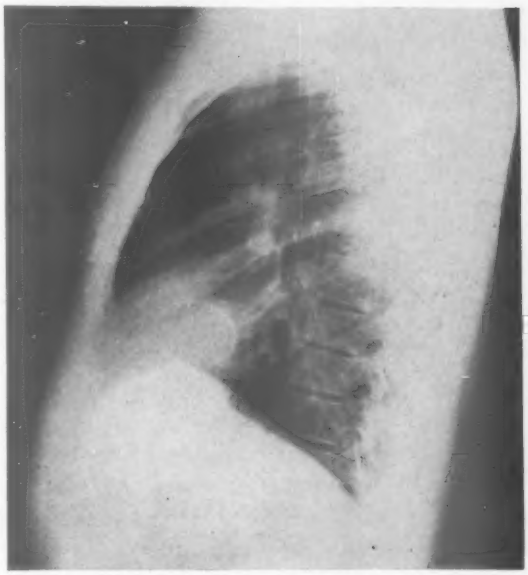

Fig. 3. Left lateral chest roentgenogram, 6 foot distance. Echinococcus cyst of heart.

Roentgenographic examinations of skull, long bones, abdomen, and gastrointestinal tract were negative.

The clinical impression was echinococcus cyst of the left ventricle.

DIFFERENTIAL DIAGNOSIS

Echinococcus cyst of the heart must be differentiated from cardiac and pulmonary conditions such as gumma, aneurysm of the heart, rhabdomyoma, dermoid cyst, simple pericardial cyst, congenital lung cyst and tuberculous abscess of the lungs or heart with calcification. In all of these conditions

the echinococcus serological tests are negative and the characteristic ring-like calcification of the echinococcus cyst seen on roentgenographic examination is absent. Since the cyst in this patient moves only with the heart beat and not with respiration, its localization is definitely cardiac. Gumma of the heart is usually associated with positive serologic findings for syphilis and in view of the patient's age must be considered unlikely. In cardiac aneurysm there is usually a preceding history of coronary occlusion. The wall of the aneurysm pulsates abnormally and less vigorously than the normal cardiac tissues. Rhabdomyoma of the myocardium usually presents itself as a non-pulsating, non-translucent zone in the heart. A caseous, partly calcified tuberculous abscess may occur in the adjacent lung and become adherent to the heart. Its occurrence in the heart is extremely rare and is usually associated with acute hematogenous disease. The calcification, if present, is less regular than with echinococcus cyst. Congenital lung cysts adjacent to the heart move with respiration and rarely show calcification.

TREATMENT

There is no specific medical treatment for echinococcus cyst of the heart. Surgical removal has been successful. In 1932 Long[8] reported the first echinococcus cyst of the heart to be removed successfully. If the patient is asymptomatic, surgery may justifiably be postponed. The cyst frequently becomes regressive and the larvae die, resulting in a spontaneous cure.

PATHOGENESIS

Echinococcus disease is most common in sheep and cattle raising areas of Iceland, Australia, South America, South Africa, Asia and Europe, where its prevalence in man is directly proportional to its prevalence in sheep, cattle, pigs, and dogs. It is uncommon in the United States and Canada where, since 1880, a few more than 500 cases have been reported. Only 5 per cent of these cases were in native born persons.[9]

The adult tapeworm, *Taenia echinococcus*, lives in the intestines of dogs and related animals. The ova which pass in the feces of the dog are ingested by sheep, cattle, horses or hogs which become the intermediate hosts for the larval or cystic stage of echinococcus granulosus. Man becomes an occasional intermediate host by the contamination of his hands, food, and drink with canine feces containing the ova. The echinococcus embryo is hatched from ingested ova in the duodenum of man. It penetrates the intestinal wall and travels by means of blood vessels and lymphatics to various parts of the body. Most commonly it enters the portal circulation and lodges in the liver where 76 per cent of all cysts are found. Less often it lodges in the lungs where 10 per cent of cysts are found. If it passes the hepatic and pulmonary capillary beds it may enter the coronary vessels and lodge in the myocardium. In the myocardium the embryo develops into an echinococcus larva. Within a few weeks the larva develops a protective cyst containing hydatid fluid. Growth of the cyst may continue for two to eight years. A single cyst may become as large as a child's head. A mature cyst has a double wall with an outer laminated membrane and an inner cellular layer enclosing cyst fluid which serves as a nutritive medium for developing scolices. Daughter and granddaughter cysts develop within the original cyst, and are common in man. Frequently after a period of growth the cyst becomes dormant or regressive, and undergoes heavy calcification. Its contents become inspissated and the larvae die. Early rupture of a cardiac cyst may occur because of the constant pull and tension of cardiac contractions. Scolices may then escape to adjacent tissues or into the blood stream resulting in cyst formation in distant organs. This condition is known as secondary echinococcosis. Symptoms of acute anaphylaxis, sometimes with fatal termination, may occur with rupture of the cyst. If leakage from the cyst is only

slight there may be few or no symptoms, and the break in the cyst wall may heal. However, rupture of the cyst may recur with more serious consequences.

SUMMARY

1. A case of echinococcus cyst of the heart is presented.

2. The clinical diagnosis is based on characteristic roentgenoscopic and roentgenographic evidence of a calcified cyst in the heart wall along with electrocardiographic evidence of myocardial changes and a positive intradermal test with echinococcus antigen in the absence of other types of cestode infestation.

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HYPERTROPHIC GASTRITIS SIMULATING INTRAMURAL TUMOR OF THE STOMACH*

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GASTRITIS manifests itself in many ways and may closely simulate other diseases.

The purpose of this report is to record and describe an interesting and instructive case in which localized gastritis simulated an intramural tumor of the cardiac end of the stomach.

CASE REPORT

The patient was a soldier, white, aged thirty-two. He presented himself at a General Hospital on June 12, 1942 (overseas) with the following history:

Chief Complaint. Discomfort and pain in the epigastrium which was relieved by eating or alkaline powders since 1941.

History of Illness. Since 1941, the epigastric distress had been moderately severe, intermittent, but seemed to be increasing in severity for the past several weeks. During the past two days he vomited several times, and on at least one occasion the vomitus was thought to contain blood. He lost about 5 pounds in two weeks.

Past History. Essentially negative except for pneumonia in February, 1941.

Family History. Negative except for the fact that patient's mother died of intestinal obstruction. Mother and sister said to have asthma.

Habits. Patient has been a heavy beer drinker for the past ten or twelve years and habitually became intoxicated about three times a week. Usually smokes one and a half to two packs of cigarettes per day.

Physical examination revealed some pallor of the skin and mucous membranes, but was otherwise negative.

At the above hospital he was found to have blood in the gastric contents, positive stool guaiac tests, and achlorhydria. Roentgenoscopic and roentgenographic examinations on July 17, 1942, revealed what appeared to be multiple filling defects in the stomach, in the cardia, on the lesser curvature, and in the prepyloric region. There was no stiffness or ulceration. The examiner suggested the presence of multiple polypi but mentioned the possibility of leiomyomata or fibromata.

Laboratory Studies. No free HCl was ever found. The total acidity ranged from 2 to 12 units on various occasions. Wassermann reaction was negative. Erythrocyte count, 4,896,000; leukocyte count 6,600, with 64 per cent polymorphonuclears and 36 per cent lymphocytes.

The patient was returned to the United States and was admitted to a General Hospital, on November 5, 1942. Study at this hospital corroborated the earlier findings.

A gastrointestinal series showed a definite tumor mass in the cardiac end of the stomach. Gastroscopic examination disclosed a large, thickened, irregular, ulcerated area on the greater curvature of the proximal stomach. This had the appearance of an infiltrative process.

On January 21, 1943, the upper abdomen was explored.

A large irregular flat tumor mass was found involving the posterior wall and extending on the lesser curvature side as far upward as the esophageal orifice, which appeared to be involved. High on the posterior aspect, the stomach was adherent to the posterior peritoneal wall along the spine. The entire mass was intramural. The serosa appeared normal. It was deemed inadvisable to attempt an abdominal resection because of the extent of the disease and the esophageal involvement.

The stomach was opened along the anterior surface and the stomach was explored by palpation to the esophageal opening in which several small nodules of tumor were felt. There was no ulceration. The mucosa appeared edematous, hypertrophic and posteriorly presented a raspberry-like appearance. A biopsy was taken from the mass in the posterior wall.

Biopsy Report. "Sections of mucosa and submucosa display slight irregularity of the mucosa and fibrosis of the submucosa. Dilated acini in mucosa and submucosa. Dilated veins in sub-

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mucosa. Scattered lymphocytes in mucosa and submucosa."

Diagnosis. Fibrosis; chronic inflammation.

A course of iodide therapy was given but the patient was not benefited. After a period of observation during which time the patient continued to have epigastric distress, and a few episodes of vomiting, he was sent to the Walter Reed Hospital for study and consideration of roentgen therapy.

Patient was admitted to Walter Reed General Hospital on April 15, 1943. At this time he appeared chronically ill and anemic. On April 16, 1943, examination of the gastrointestinal tract showed the presence of a lemon-sized circumscribed mass on the posterior wall of the cardia of the stomach very near the esophageal orifice. The gastric wall was stiff at the site of the tumor, and the cardia appeared to be fixed under the diaphragm. The remainder of the stomach was flexible and not definitely abnormal except for the presence of thick gastric rugae. The esophagus and duodenum appeared normal.

Roentgenologist's Impression. Benign intramural tumor (leiomyoma or neurofibroma).

Gastroscopic Examination. May 2, 1943. The stomach contained about 70 cc. of clear whitish fluid. Along the greater curvature and the posterior wall there was irregular thickening of the mucosa without ulceration or localized tumor mass. The esophageal-cardiac junction could not be adequately visualized.

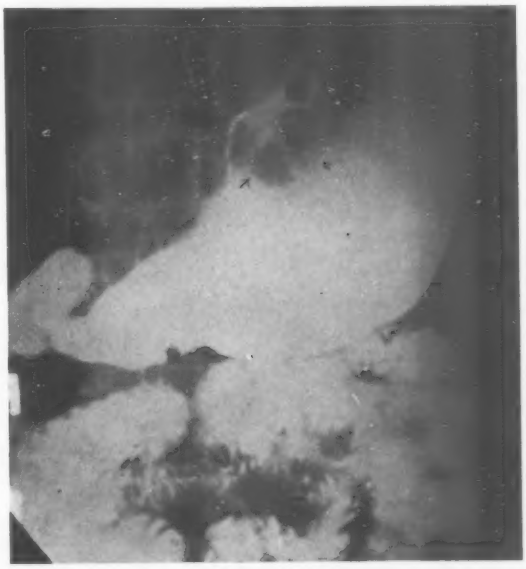

FIG. 1. Original appearance at overseas hospital on July 23, 1942. The filling defect in the cardia is well shown with the stomach completely filled.

FIG. 2. Trendelenburg position. Roentgenogram taken at Walter Reed General Hospital in April, 1943, using a few swallows of barium. The foot end of the table was elevated 45 degrees. The air bubble in the pars media shows heavy, somewhat ragged gastric rugae.

Impression. "Diffuse benign gastric tumor, possibly leiomyoma."

The patient was presented at the tumor board where it was decided that he should be explored by the transthoracic approach in order to gain access to the cardia.

After a furlough the roentgen examination of the stomach was repeated in July, 1943. As no change in the appearance was found, the following operation was carried out:

On July 7, 1943, a left thoracotomy incision was made, the eighth rib resected, and the left pleural cavity was entered. An incision was made in the left leaf of the diaphragm from the esophageal hiatus laterally to the costal margin.

The stomach was found to be firmly adherent to all surrounding structures: posteriorly to the

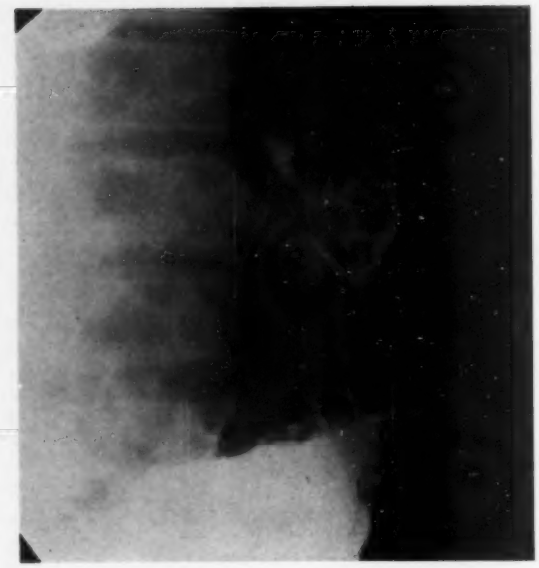

FIG. 3. Mucosal relief study of cardia and fundus. Note the smoothly ovoid contour of the mass and absence of ulceration. April, 1943.

pancreas and peritoneum; superiorly to the diaphragm and right lobe of the liver; and inferiorly to the transverse colon and omentum. The stomach was bulky and its walls markedly thickened, measuring 3 cm. in the fundus. In the cardiac portion, near but not involving the esophagus, there was a large oval mass about 8 by 4 by 5 cm. in size. This was palpated through the stomach wall. It was firm and was thought to be a tumor.

The adhesions binding the stomach were freed by sharp dissection. The spleen was rapidly removed in order to obtain a free approach to the greater curvature. The left gastroepiploic vessels were transfixed, ligated and cut. The left gastric artery was isolated, doubly ligated and divided. The esophagus was then cut across 1 cm. proximal to its entrance into the stomach. Two-thirds of the proximal portion of the stomach was then removed. The stomach stump was closed with continuous lock stitch for the mucosa and interrupted Lembert suture for the serosa. The stump of the stomach was closed in such a way as to make a tube, employing a portion of the lesser curvature. This portion of the stomach was then sutured to the under surface of the diaphragm without tension. An opening 2 cm. in length was made in the stomach and the open end of the esophagus was anastomosed to it. The anastomosis was performed by first suturing the serosa of the esophagus to the serosa of the stomach with

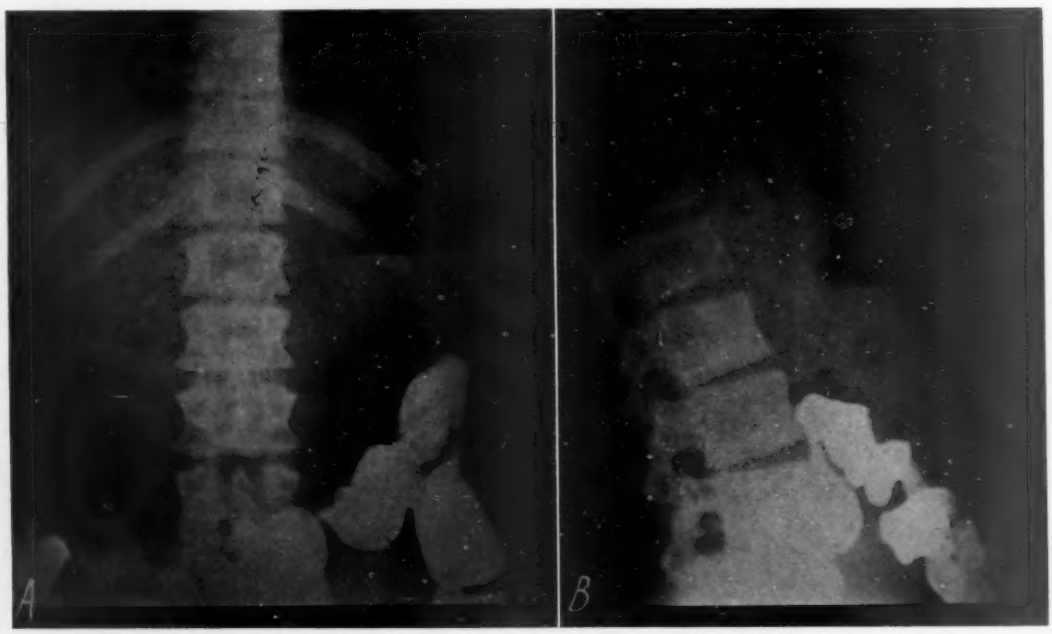

FIG. 4, *A* and *B*. Gastric pneumographic study. The patient drank sodium bicarbonate and water. The roentgenograms (anteroposterior and lateral) were taken with the patient standing erect. April, 1943. The tumor on the posteromesial wall of the cardia is projected into the gas bubble.

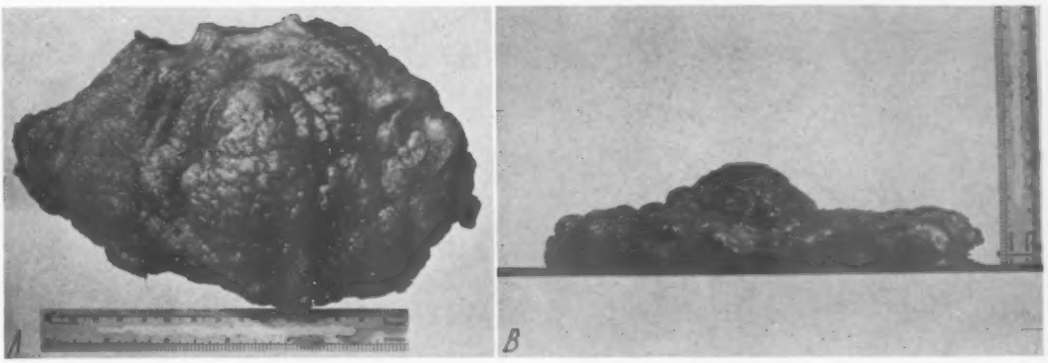

FIG. 5, *A* and *B*. Surgical specimen. Fresh gross appearance of resected stomach showing the closely packed and heaped up thick gastric rugae.

fine silk. The mucosa of the esophagus and the mucosa of the stomach were then sutured with interrupted fine silk. Anteriorly, the serosal layers were approximated with interrupted silk sutures. There was no tension on the suture line.

The opening in the diaphragm was closed with interrupted No. 2 mattress sutures, after placing 5 grams of sulfanilamide in the peritoneal cavity. Five grams of sulfanilamide were then placed in the pleural cavity and the thoracotomy wound closed, after the lung had been expanded.

Examination of Specimen S-20433—resected portion of the stomach and esophagus: weight, 360 grams. The serosal surface is smooth, but shows some dense fibrous bands. The mucosal surface throughout is thrown into large irregular folds and there is an area just below the esophageal orifice measuring 6 by 4.5 cm. in which the mucosa projects as a large mass 3.5 to 4.0 cm. above the surrounding mucosa. There is no ulceration. The mass is situated posteriorly, and partially obstructs the esophageal opening. Sections through this area reveal diffuse thickening of the mucosa which varies from 0.5 to 1.5 cm. The muscular wall is sharply delineated and appears fibrous and edematous. This measures 1 to 2 cm. in thickness.

Microscopic Examination. Sections through the tumor mass and other portions of the stomach show diffuse hyperplasia of the mucosa which is entirely distinct from the underlying muscle. The gastric mucosa everywhere shows adenomatous hyperplasia of the mucous glands, associated with dense lymphoid and plasma cell infiltration. This infiltration extends down into the submucosa and muscularis and is accompanied in some areas by fibrosis. In some areas the glandular structures are markedly dilated, filled with mucus, and the epithelial lining is compressed and atrophic. There is no evidence of malignancy.

Diagnosis. Adenomatoid hyperplasia of the mucous glands with chronic, diffuse gastritis.

On the second postoperative day the temperature rose to 105° F., there was evidence of peritoneal irritation, fluid in the left chest and thoracentesis yielded blood-tinged fluid and some air. The abdomen became tender throughout, but not rigid, pulse and temperature continued to rise, and on the morning of July 12, 1943, the patient died. Autopsy was performed.

Steenman Autopsy (No. 3259 Reg. No. 193942). The left pleural cavity contained

FIG. 6. Cut section of surgical specimen. All the coats of the stomach are greatly thickened, but the pseudotumor consists of only mucosa and submucosa. (Army Medical Museum negative No. 77893.)

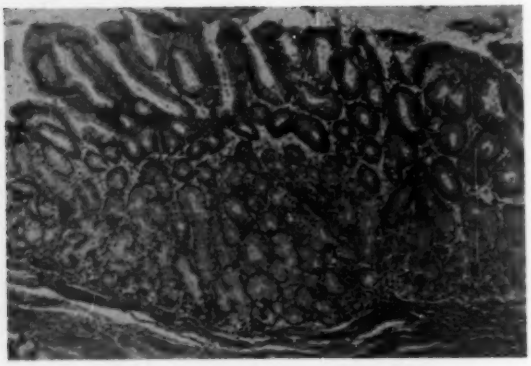

FIG. 7. Surface epithelium. Photomicrograph (×230) (Army Medical Museum negative No. 77898.) Surface epithelium underlying mucous glands resembling the glands normally found in the pyloric region.

1,500 cc. of thin brownish fluid which was foul smelling. The left lung was completely collapsed. The right lung showed congestion and edema. The collapsed left lung showed thick plastic exudate over the visceral pleural surface.

Dense adhesions were found between the remaining portions of the stomach and the left lobe of the liver and extending to the inferior surface of the left diaphragm.

The cardiac end of the stomach had been surgically removed. There was a reconstruction along the lesser and greater curvatures of the stomach forming a tube-like structure which was anastomosed to the esophagus. At the site of the anastomosis of the esophagus with the stomach, there was separation of the sutures, tearing of the esophageal wall and leakage of the gastric contents into the thoracic cavity. The wall of the esophagus was thin and friable.

The mucosa of the stomach showed congestion and in the antral portion several small adenomatous-like areas were found. There was no ulceration or other abnormality of the pylorus or the remainder of the gastrointestinal tract.

There was no generalized or localized peritonitis, and the remaining organs were not grossly or microscopically abnormal.

Cause of death: (1) pyothorax, acute, left, severe, secondary to break-down of esophagogastric anastomosis; (2) collapse, left lung, secondary to (1); (3) adenomatoid hyperplasia of mucous glands of the stomach with chronic diffuse gastritis.

DIFFERENTIAL DIAGNOSIS

A space-taking lesion in the cardiac portion of the stomach in a young man with achlorhydria, weight loss, and hemorrhage, necessitates consideration of the following in differential diagnosis:

Malignant Conditions:

1. Carcinoma
2. Lymphoblastoma (particularly lymphosarcoma)
3. Malignant degeneration of polyp
4. Hemangio-endothelioma
5. Malignancies arising from benign tumors
   (a) Leiomyosarcoma
   (b) Fibrosarcoma
   (c) Neurosarcoma (neuroblastoma)

Benign Conditions:

1. Polyps (a) (simple polypoid)
   (b) (polyadénomes en nappe)
2. Leiomyoma
3. Fibroma
4. Fibromyoma
5. Neurofibroma
6. Aberrant pancreatic tissue
7. Lipoma
8. Angioma and "osteoma" (rare)
9. Some forms of hypertrophic gastritis

1. Malignant tumor was discarded as a possibility in this case because there was no demonstrable progression or metastasis of the tumor during the ten month period

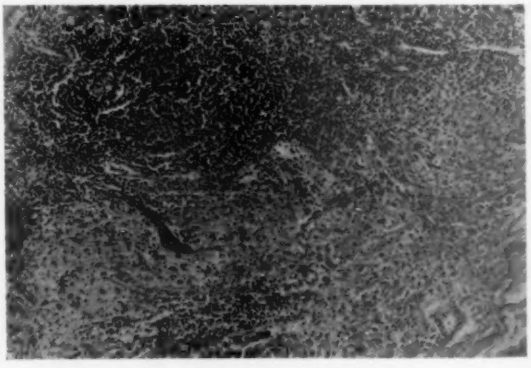

FIG. 8. Submucosa. Photomicrograph (×145) (Army Medical Museum negative No. 77897.) Dense lymphocytic infiltration and bizarre proliferating fibroblasts found throughout the submucosa.

of observation. Another important reason was the presence of an apparently intact mucosa overlying the mass. (In favor of malignancy, however, were the findings at the exploratory operation in January, 1943, the fixation of the cardia to the posterior peritoneal wall, and the small nodules found in the esophageal orifice.)

2. Benign polyps, fibroma, lipoma, and other tumors arising from the epithelial lining of the stomach were discarded because the lesion was not polypoid, discrete, pedunculated, or mobile.

3. Aberrant pancreas usually presents a more rounded defect with a central "dimple" at the duct orifice.[13,16] Also this is uncommon.

4. Extramucosal, intramural tumor of the stomach appeared to be the diagnosis of choice for several reasons:

(a) There was evidence of benignancy.

(b) The tumor was lemon sized, sharply outlined and protruded into the lumen from only one side, forming an obtuse angle with the stomach wall.

(c) It was sessile, and covered by what appeared to be intact, relatively smooth mucosa.

(d) The intact mucosa overlying the mass offered a possible explanation for the "tumor-negative" biopsy report in January, 1943.

(e) The lower esophagus and lower half of the stomach appeared relatively normal at roentgen examination and gastroscopy.

(f) While deep ulceration frequently occurs in intramural gastric tumors, the absence of ulceration is not significant.[13,16]

(g) The descriptions in the literature[5,6,13,14,16,17,20] appeared to be applicable in this case.

5. Localized hypertrophic gastritis with adenomatous characteristics was, unfortunately, not strongly considered because of the large size of the mass, the stiffness of the wall, the normal appearance of the stomach distal to the lesion and the strong prejudicial conviction that we were dealing with a tumor.

DISCUSSION

Inflammatory diseases of the stomach have many times been mistaken for tumors. Attention was first called to the gross similarity of hypertrophic gastritis and carcinoma by Brunn and Pearl[3] in 1926. Since then, Schlindler,[18] Golden,[9] Buckstein,[4] and others, have contributed to the literature on the subject. In 1943 Freedman, Glenn and Laipply[7] reported 5 cases.

The diffuse types of gastritis ranging from the atrophic to the markedly hypertrophic and polypoid are seen frequently by the roentgenologist, but are best studied and classified by the gastroscopist. These are infrequently mistaken for tumors.

The gastritides encountered in the pars antrum and in the prepyloric region are more difficult to recognize and are still frequently misdiagnosed by the roentgenologist, the gastroscopist and even the surgeon who palpates the stomach at the operating table. The great frequency of gastritis in this portion of the stomach[8] prevents our overlooking this disease.

The localized gastritides, examples of which are shown by Buckstein,[4] Freedman, Glenn and Laipply,[7] and the case at hand are practically never diagnosed by any means before reaching the pathologist. This disease may occur in any portion of the stomach, but is slightly more common in the upper half and on the greater curvature.

In localized gastritis the mucosa is nearly always thickened to a variable degree. This may vary from 3 mm. to several centimeters. The height of the rugae is dependent upon the condition of the muscularis mucosae. The mucosal surface is usually coarsely granular and composed of closely packed mammilations. The mucous glands are tortuous, enlarged and deep. Frequently the glands are filled with secretions, producing minute cysts. The thickening of the mucosa may be uniform or irregular, in which case there is a definite polypoid character of the surface. Small or large superficial erosions of the mucosa account

for the slight bleeding usually found. Actual ulceration occasionally occurs. Small or larger areas of mucosal hyperplasia are found, which, when contiguous, form a plateau or thick, stiff plaque. From the description of Ménétrier's[11] "polyadénomes en nappe" which he considered as a true polyposis, it is apparent that hypertrophic change in gastritis merges gradually into inflammatory polyposis. (The small, discrete, pedunculated, widely separated simple polyps are evidently entirely different and represent true neoplasia.[1,2,4,12,15])

The protruding mass which simulates tumor in these cases is merely a piling up and crowding together of the hypertrophic, redundant, inflammatory mucosa. The submucosa, the muscularis mucosae and the deeper layers of the stomach do not take part in the formation of the mass or pseudotumor, although they, too, are usually thickened.

Throughout all the coats of the stomach there is a marked leukocytic infiltration. This is always composed of lymphocytes, plasma cells and monocytes. There may be slight, moderate or marked superimposed acute gastritis with accompanying polymorphonuclear leukocytes, edema, hemorrhage, or areas of necrosis.

Inflammation is found microscopically to involve the mucosa and submucosa in all cases, and the muscularis in most clinically significant ones. In the above case the involvement extended to the serosa, giving rise to adhesions to other structures.

Gastric polyposis has a high incidence of malignant change, varying in different series from 25 per cent[5] to 41 per cent.[2] This is a danger, also, in the "en nappe" or inflammatory type which, as indicated above, is probably merely a phase in localized chronic gastritis.

Achlorhydria is strikingly common in both types of polyposis, diffuse gastritis and in the localized adenomatous form with which we are concerned here. Achlorhydria is even more common in these benign diseases than in carcinoma[15] and is presumably the result of diffuse chronic disease and interference with the function of the acid secreting glands. Even the "localized" type is probably a late focalization phenomenon following the diffuse phase or phases of the disease. The treatment is surgical removal because of the high incidence of malignant change and hemorrhage. The disease may involve the lower esophagus and the entire stomach, a fact of importance to the surgeon. The granulomatous inflammatory disease which rendered the esophagus weak and friable undoubtedly contributed to the postoperative disruption in the above case.

CONCLUSION

Localized hypertrophic gastritis with or without polypoid or adenomatous changes must be carefully considered in the differential diagnosis of gastric tumors.

Chronicity, slight bleeding, vomiting and achlorhydria are suggestive manifestations of the disease.

As is seen in the above case, the roentgenoscopic appearance may be identical with that of the intramural tumors.

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MULTIPLE DIFFUSE PANCREATIC LITHIASIS

ROENTGEN ANATOMY OF THE PANCREAS: CASE REPORT

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PUBLISHED cases of pancreatic lithiasis are not many, and a completely satisfactory picture of this entity and its complications has not yet been established. This case report is presented in particular from the following viewpoints: First, the multiple, diffuse nature of the calcifications offers an opportunity to study roentgenologically the anatomical relationships of the pancreas; second, abnormalities of small intestinal pattern related to the pancreatic disease are demonstrated roentgenologically; third, this case represents an early stage in pancreatic dysfunction as indicated by definite changes in the character and content of the stool in the absence of any gross clinical manifestations of pancreatic insufficiency.

FIG. 1. This roentgenogram shows multiple, diffuse calcifications throughout the pancreas. Most of these are probably located in the main pancreatic duct and its branches. The head of the organ overlies the first and second lumbar vertebrae. The body and tail of the organ extend diagonally upward into the left upper quadrant.

CASE REPORT

The patient, aged thirty-five, gave a history of twelve acute attacks of severe upper abdominal pain during the past five years. The attacks usually started with pain in both hypochondriac regions, particularly on the right, with radiation to the back, under both shoulder blades, and to both costovertebral angles. The only noteworthy prodrome was constipation; there was no relation to fat ingestion or other diet. The attacks were accompanied by perspiration, relieved by morphine and generally subsided within a few days. There was no history of stone in the stool, jaundice, tetany or urticaria. In the intervals between attacks the patient was in good health. Childhood diseases included measles, chicken pox and mumps (no abdominal complications). Surgical history included a tonsillectomy at the age of six, herniaplasty at the age of eight, and an appendectomy at twenty-two. His teeth had been extracted seven years prior to admission.

The patient was first seen during an attack of severe abdominal pain as noted above. Tenderness was present beneath the right costal margin. The white blood count was 12,200, 69 per cent segmental forms, 19 per cent lymphocytes, 7 per cent stabs, 4 per cent eosinophiles, 1 per cent monocytes. The red blood cell count was 4.18 million. Clinically, the present attack was considered to be one of gallstone colic, as were his previous attacks. Under morphine treatment, the pain subsided considerably, although a slight residual pain persisted for several days.

Roentgen examination of the abdomen (Fig. 1) revealed numerous calcifications conforming to the anatomical location of the pancreas. A diagnosis of multiple, diffuse pancreatic lithiasis was made. Gallbladder study (Fig. 2), intravenous pyelography (Fig. 3), barium study of the large bowel (Fig. 4), and lipiodol study of the bronchial tree showed no roentgenologically

demonstrable abnormalities of these organs. The calcifications were readily visualized on roentgenoscopy after thorough accommodation (some authors have failed to find them[5]). Roentgen studies of the small bowel (Fig. 5, 6, 7 and 8) showed abnormalities of the small bowel pattern including marked hypermotility, variation in motility, hypertonicity, coarsening

Fig. 2. This roentgenogram shows the gallbladder filled with dye. The calcifications in the head of the pancreas are seen to the left of this, over the first and second lumbar vertebrae. Although not found in this case, gallstones are frequently present in cases of pancreatic lithiasis.

and obliteration of mucosal folds and segmentation.

Repeated stool examinations were done over a period of several weeks. Bowel movements occurred regularly, twice daily. The stool was consistently well formed and very bulky, and the color varied between a clay color and light tan. Microscopic examination invariably showed a marked increase in muscle fiber content, and very many fat globules and fat crystals. Sudan stain was used to further demon-

Fig. 3. Intravenous pyelogram shows the relation of the head of the pancreas to the hilus of the right kidney. The body and tail extend across the upper pole of the left kidney to the hilus of the spleen.

Fig. 4. Barium enema shows the head and body of the pancreas above the middle of the transverse colon. The tail is in direct contact with the splenic flexure.

Fig. 5. Barium meal study shows the head of the pancreas to be located within the duodenal loop. The body extends above the lesser curvature of the stomach. The duodenal loop is represented by a thin line of barium without any mucosal markings. Haziness and smoothness of outline of the upper jejunal loops are present.

strate the abnormal amount of fat globules. The increase in muscle fiber and fat content was present, even on a controlled low protein, low meat and low fat diet. Determination of total nitrogen excretion in the stool on the standard Schmidt diet revealed 4.995 grams of nitrogen to be excreted in a single day, much above the normal value.

Further laboratory examinations included two normal glucose tolerance tests; the serum amylase value was 93 units, the serum lipase value less than 0.05 unit, both within normal limits. The urinary amylase value was also normal. Serum calcium determinations were 9.2 mg. and 11.3 mg. per 100 cc. Total blood proteins were 6.2 grams per 100 cc.; albumin was 4.1, globulin was 2.1.

ROENTGEN ANATOMY OF THE PANCREAS

Although the calcifications in this case do not completely outline the pancreas, and associated pancreatic disease may have distorted somewhat the size and relationships of the gland, the roentgen appearance conforms fairly closely with anatomical descriptions of the pancreas.[4] The head of the pancreas overlays the first and second lumbar vertebrae (Fig. 1); it fits into the concavity of the duodenal loop (Fig. 5, 6, 7 and 8). Defects of the barium-filled duodenum and pylorus due to carcinoma and other lesions of the head of the pancreas have been frequently described in the roentgenologic literature. From the head, the organ extends diagonally upward into the left upper quadrant. The body of the pancreas reaches above the lesser curvature of the stomach. This explains the roentgenologically demonstrable deformity of the lesser curvature of the stomach due to tumors of this portion of the pancreas. The tail of the pancreas crosses the upper part of the left kidney (Fig. 3) and extends to the hilus of the spleen. Here it is in direct relation with the splenic flexure of the colon, as well (Fig. 4).

Fig. 6. Small bowel study again shows the obliteration of the normal mucosal pattern of the duodenal loop. Exaggeration of the mucosal folds, hypertonicity, and irregularity of the pattern of the jejunum are noted.

In the dissection room the pancreas, a retroperitoneal organ, presents fairly constant relationships with the duodenum, kidneys, stomach, transverse colon and spleen. In the living, however, factors of habitus, assuming the erect posture, and respiration change its roentgen relationships, particularly with intraperitoneal organs of free mobility such as the stomach and transverse colon. Thus, in the erect posture the stomach and transverse colon fall considerably below the body of the pancreas. Factors of projection must also be considered.

ABNORMALITIES OF SMALL INTESTINAL PATTERN

Abnormalities of small intestinal pattern and motility have been demonstrated roentgenologically in sprue, celiac disease, and vitamin deficiency states,[3] with drugs,[2,6,11] inflammatory diseases of the small intestine,[11] liver disease, allergy,[11]

Fig. 7. Small bowel study shows considerable thickening and irregularity of the mucosal pattern of the duodenum and jejunum. Segmentation is present.

Fig. 8. This roentgenogram demonstrates marked hypermotility of the small bowel. Barium is present in the hepatic flexure fifteen minutes after ingestion. Considerable variation of small bowel motility is noted by comparison with Figure 7 in which barium has only reached the ileum at the end of one hour.

emotional states, and with variation in the bowel content,[9] as well as in other conditions. Motor intestinal disturbances including gastrospasm and pylorospasm have been noted in pancreatic lithiasis.[10] This case demonstrates several noteworthy changes in the small bowel including segmentation, obliteration of mucosal pattern, exaggeration, irregularity and coarsening of the mucosal folds, and hypertonicity. Figure 8 shows the presence of barium in the ascending colon at the end of fifteen minutes after ingestion, indicating marked hypermotility. Variation in motility is demonstrated by comparing this with Figure 7 in which the barium has only advanced to the ileum at the end of one hour. There was no gastrospasm or pylorospasm.

The mechanism of production of the abnormal small bowel pattern in this case may be related to a vitamin, protein, or other

deficiency state[3,11] due to the pancreatic disease. A nerve reflex or chemical effect[2,6] from the diseased pancreas may be implicated, especially with regard to the changes in motility. The effect of a large amount of undigested fat on intestinal pattern has been shown.[9] A further interesting consideration in this case is the possible effect of the abnormal amount of muscle fiber and increased protein on the intestinal pattern.[9] This lack of digestion of muscle fiber, and increased protein excretion are even more diagnostic of pancreatic insufficiency than is the lack of proper fat digestion.

PANCREATIC INSUFFICIENCY

Although pancreatic lithiasis is roentgenologically a distinct entity, its clinical significance in great measure depends on the associated pancreatic disease and insufficiency. Etiologically, it is related to pancreatic necrosis.[7] Stones have been found in association with hemochromatosis,[10] and with carcinoma of the pancreas.[10] Changes in the pancreas secondary to the presence of stones include atrophy, fibrosis, and cystic changes;[7] the islands of Langerhans may be affected, although usually late in the process. Secondary fatty changes may occur in the liver.[10]

Marked weight loss, wasting and cachexia occur in lithiasis with advanced pancreatic insufficiency due to the impaired digestion of fats and proteins, and associated vitamin and other nutritional deficiencies.[10] Frank diabetes may result from atrophy of the islands of Langerhans.[10] Liver metabolism is also affected.[10] Tuberculosis[10] and other pulmonary complications[7] not infrequently supervene. Lipiodol study of the bronchial tree is indicated, particularly in view of the pulmonary changes that have been so frequently found in cystic fibrosis of the pancreas in infancy.[2]

This patient did not manifest any gross clinical evidence of pancreatic insufficiency. There was no wasting, cachexia, diabetes, or evidence of secondary changes in the liver, lungs, or other organs. A diagnosis of early pancreatic insufficiency is justifiably made, however, on the basis of the markedly increased excretion of fat and protein in the stools, with characteristic color and bulk.[8] Substitution therapy with pancreatic enzymes, and a controlled high calory, high vitamin diet may prevent some of the serious results of pancreatic insufficiency noted above.[1]

SUMMARY

A case of multiple, diffuse pancreatic lithiasis representing an early stage of pancreatic insufficiency is reported. Changes in the small intestinal pattern are demonstrated roentgenologically. The roentgen anatomy of the pancreas is discussed.

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MULTIPLE PLASMOCYTOMA OF THE JEJUNUM*

REPORT OF A CASE

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THE plasmocytoma, a tumor composed almost exclusively of plasma cells, may occur in nearly any part of the body. By far the most frequent site is the bone marrow, constituting the plasma cell myeloma, either solitary or multiple. Less commonly, these tumors occur outside the bone marrow. Hellwig[3] recently reviewed 128 cases (127 published cases and 1 of his own) of "extramedullary plasma cell tumors." Most of these occurred in the respiratory passages (64 cases) and in the conjunctiva (47 cases). Only 5 cases are reported in which the tumor involved the small intestine. In 1924, North[5] reported the case of a forty-seven year old woman who suffered abdominal discomfort and progressive weakness for three months. A laparotomy, performed to relieve an intestinal obstruction, revealed tumor involving two segments of about 35 cm. of ileum. On microscopic examination, the tumor was found to be infiltrating all intestinal layers and composed of plasma cells with numerous mitoses and little intercellular substance. The mesenteric lymph nodes were not examined. Vasiliu and Popa,[9] in 1928, reported the autopsy findings in a woman, aged thirty-two. They described ulcerating nodular tumors in the mucosa of the stomach, ileum, and sigmoid colon. There were clumps of mesenteric lymph nodes compressing the ileum. All these areas showed masses of plasma cells. Razzaboni[6] reported a case showing ulcerated tumors in the terminal ileum, cecum, and appendix. These tumors were composed exclusively of plasma cells. In 1930, Vallone[8] reported the case of a twenty-four year old man who presented a history of recurrent attacks of severe right lower abdominal pain suggestive of chronic intestinal obstruction. A first laparotomy was limited to draining a local peritonitis. At a second operation, a tumor obliterating the lumen of the ileum was found. The tumor was composed of plasma cells and some lymphocytes. It had invaded the submucosa and muscularis. Brown and Liber[1] described the case of a Negro, aged fifty-seven, who had had a purulent rectal discharge for ten to fourteen years. There was a twenty year history of lues. Numerous polypoid masses encircling the rectum were noted. At autopsy, following death from pneumonia, there were found numerous masses of firm, yellowish-white tissue elevated above the serosa and distributed throughout the entire ileum. At the hepatic flexure of the colon there was a localized chronic perforating abscess associated with a polypoid mass and infiltration of the walls of the colon. The perirectal tissues showed the same infiltration. These intestinal masses and the regional lymph nodes were composed of "solid sheets of plasma cells (about 80%)" and lymphocytes with varying degrees of fibroblastic induration. Amitotic division of plasma cells was observed. These plasma cell collections infiltrated all the intestinal coats and the epiploon. There was invasion of the blood vessels by similar cell masses. These authors state that the findings did not resemble regional ileitis granuloma or granuloma venereum. Recently we have had occasion to observe the roentgenograms of a case seen at another hospital by Dr. C. L. Hinkel.[4] These showed multiple constrictions in the small intestine with destruction of the mucous membrane. A biopsy from one of the mesenteric lymph nodes was taken. The histopathological picture was interpreted by one of us (A.P.S.) as plasmocytoma.

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Swenson,[7] in a recent review of small intestinal tumors, included the following case. However, the condition is of such rarity it seems advisable to report it in further detail under the above title.

CASE REPORT

R. S. (610245), a Costa Rican merchant, age thirty-five, was first seen by Dr. C. Flood on May 9, 1940. He presented a history of three episodes of gastrointestinal hemorrhage in the preceding three years. In 1935 the patient was discovered to have syphilis. After two years of intensive treatment, his blood Wassermann became negative and he was discharged as cured. In 1937 he experienced a rather severe intestinal hemorrhage for which he received two transfusions and was later treated with iron. One year following this episode, a similar hemorrhage occurred. At this time, his blood Wassermann again became positive and treatment was re-instituted. One week after a third neosalvarsan injection, another hemorrhage occurred. With this episode of melena, the patient vomited but the vomitus did not contain blood. Examination of the stools at that time did not reveal any ova or parasites. Since this last hemorrhage which occurred two years prior to his first visit, the patient had suffered a dull, steady pain in the left upper and lower abdomen. This was unrelated to meals and was only partially relieved by alkali. Nausea was quite frequent, and the patient resorted to induced vomiting for relief. No difficulty or change in bowel habit was experienced. Although anorexia was a prominent symptom, the patient had not lost weight. There was never any jaundice or fever.

Past History. As a youth he had malaria. Following an attack of "flu," he had rheumatism but the joints were not swollen nor red. The illness was of short duration. In his early youth he contracted a neisserian infection for which he received treatment for eight months. There have been no recent symptoms referable to this. Except for a myringotomy and nasal operation in 1922 he had never undergone surgery. A review of the systems was otherwise non-contributory.

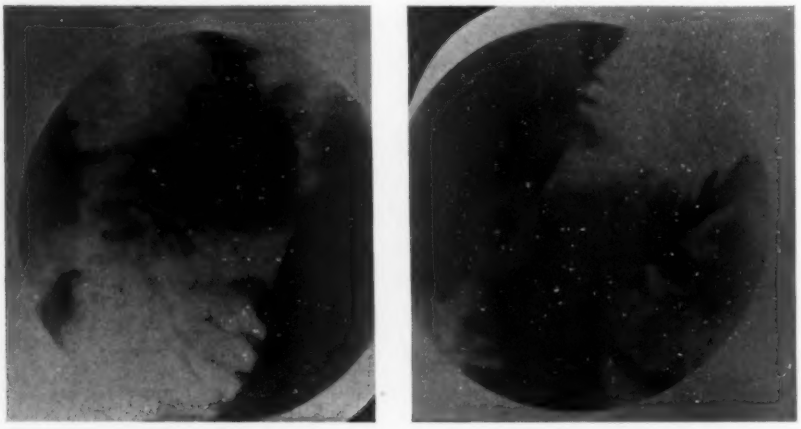

FIG. 1. Pressure roentgenograms of the narrowed area in the jejunum showing destruction of the mucosal folds. The circle on the left shows an irregularity on one side of the constriction suggesting an ulcer.

Physical examination revealed a rather pale depressed man, looking chronically ill. No jaundice, cyanosis or dyspnea was observed. Eyes: dilated pupils which reacted well to light and accommodation. Throat: negative. There were no palpable lymph nodes. Heart and lungs: negative. Abdomen: no palpable masses or localized tenderness. There was no abdominal distention. The liver, spleen, and kidneys were not palpable. Rectal examination, including anoscopy, disclosed a few small hemorrhoids and dilated crypts. No rectal masses were present. Mild varicosities were noted in the left leg.

Laboratory Findings. Hemoglobin, 13.3 gm. (92 per cent); erythrocyte count, 5,140,000; leukocyte count, 7,200, with polymorphonuclear leukocytes 56 per cent (0-6-50), lymphocytes 32 per cent, monocytes 9 per cent, eosinophiles 3 per cent. The blood smear showed

slight anisocytosis. No parasites were seen. Platelets appeared normal. Kline test, negative. Urinalysis, negative.

A gastrointestinal series was done on May 10, 1940. A narrow constriction which had slightly irregular walls was noted in a loop of lower jejunum. Pressure roentgenograms made of this area (Fig. 1) showed an apparent absence of the mucosal folds over a short distance. The constriction appeared to be 3 cm. in length and varied in width from time to time. An irregularity was noted on one side of it which suggested an ulcer (Fig. 1). Other loops in this immediate neighborhood appeared quite narrow but it was impossible to be certain about loss of mucosal folds except in this one area. Under the stimulus of pressure these loops emptied rapidly. The patient localized his pain in this area in the left iliac fossa. Distal to this the ileum and cecum showed nothing remarkable. The esophagus and stomach appeared normal although the stomach was quite hypertonic and sluggish with a spastic antrum.

The patient was admitted to the Presbyterian Hospital one week later. Preoperative decompression of the intestine was attempted with the Miller-Abbott tube. However, the tip of the tube was arrested for thirty-six hours at the ligament of Treitz. The surgeon later noted the presence of organic obstruction just distal to this area which accounted for the arrest. On May 20, 1940, a laparotomy was done by Dr. Louis Rousselot. Beginning immediately at the ligament of Treitz and continuing at almost equally distant intervals of between 6 and 8 inches along the course of the jejunum, there was a series of six identical, annular, soft constrictions of the bowel of approximately 2.5 to 3 cm. in length with intervening normal appearing intestine for a distance of about 14 to 16 cm. The serosa overlying the lesions was a dull grayish-white color. The intestine was puckered around its circumference. The process apparently extended several millimeters into the mesenteric attachment. Careful examination of the mesentery revealed no grossly abnormal lymph nodes. The stomach, duodenum, terminal ileum, colon and liver were all explored and were grossly normal. A biopsy was taken at the site of the third lesion and examined by frozen section. Upon finding evidence of malignant tumor, the jejunum with attached mesentery at this site was resected and an end-to-end anastomosis effected. Gross and

Fig. 2. Roentgenogram taken fifteen minutes after the ingestion of barium and showing a narrowed area about 3 cm. in length in the proximal jejunum. Dilatation of the jejunum proximal to the constriction is demonstrated.

histological examination of the specimen is discussed below.

On the second postoperative day, the patient passed both dark and bright red blood by rectum. Except for this episode, the postoperative course was uneventful. There was a temporary secondary anemia without evidence of abnormal white blood cells. The urine was negative for Bence-Jones protein. As a therapeutic trial, radiotherapy was instituted. He received 1,860 r (measured in air), with 200 kv., half-value layer 1.8 mm. Cu, to an anterior abdominal field 20 by 20 cm. This course of treatment extended over a period of two months. It was then discontinued because of recurrent nausea and a tendency to leukopenia. On July 26, 1940, about two months after operation because of a persistent secondary anemia attributed to the irradiation, a transfusion of 500 cc. of whole blood was given. At this time, the leukocyte count was 3,500 with polymorphonuclears 66 per cent (0-1-65), lymphocytes 20 per cent, monocytes 12 per cent, eosinophiles 2 per cent. Other laboratory findings: serum protein 6.9 per

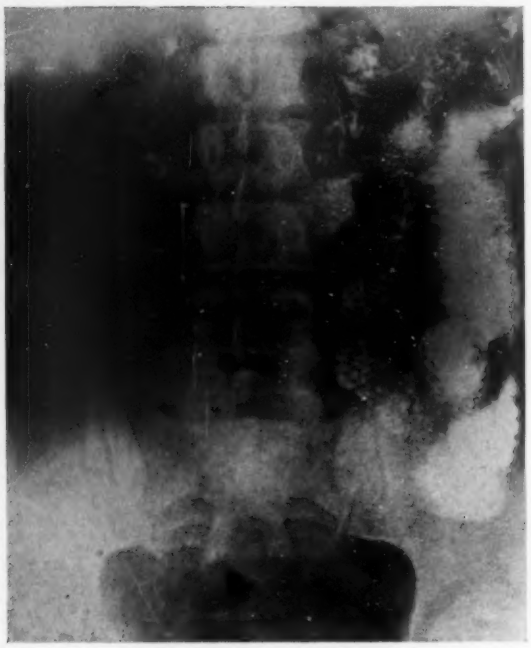

FIG. 3. Roentgenogram showing a second constriction in the lower jejunum about 2 cm. in length and about 15 cm. distal to the narrowing demonstrated in Figure 2.

cent, albumin 4.1, globulin 2.8, euglobulin 0.3 per cent, serum calcium 9.0 mg. per 100 cc., serum nonprotein nitrogen 26 mg. per 100 cc., serum phosphatase 3.4 Bodansky units per 100 cc., serum cholesterol 136 mg. per 100 cc., serum bilirubin, negative.

On August 12, 1940 (approximately three months after operation) another gastrointestinal roentgen study was done. The barium column was seen to pass rapidly through the duodenum and into the jejunum to be temporarily arrested in the proximal jejunum about 8 or 10 inches distal to the ligament of Treitz. Here, a narrowed segment about 3 cm. in length was noted (Fig. 2). About 6 inches distal to this a second narrowed zone about 2 cm. in length was observed (Fig. 3). There was no obstruction. The motility of the small intestine as a whole was normal. There was hypertonicity of the lower ileal loops. Except for rather large gastric mucosal folds, no roentgenologic abnormalities were observed in the remainder of the gastrointestinal tract.

The patient returned to his home in Costa Rica. It was learned that on May 14, 1942, approximately one year after his hospital admission, the patient died. His death occurred on the fifth day following an operation for attempted relief of episodes of intestinal obstruction recurrent over a period of six weeks. At this laparotomy, the Costa Rican surgeons described an ulcerous segment of jejunum just distal to the previous enterectomy. This contained a tumor completely obstructing the lumen of the jejunum. Two additional tumefactions were observed. The lesions were not examined microscopically.

Pathological Findings. Gross examination of the resected jejunum showed an ulceration with indefinite borders extending around the entire circumference of the intestine and measuring 2.7 by 3 cm. (Fig. 4). The jejunal wall was thickened in this region. The histological sections show normal intestinal wall ending abruptly where the mucosa is destroyed and replaced by granulation tissue infiltrated by enormous numbers of plasma cells together with a few lymphocytes. The plasma cells infiltrate the entire thickness of the jejunum and pass out into the mesenteric fat. Some of the regional lymph nodes of the mesentery are almost solidly filled with plasma cells. For the most part the plasma cells are of relatively normal appearance. A number of them, however, are multinucleated and they show mitoses on an average of one in every seven or eight high power fields (Fig. 5). The sections were interpreted as plasmocytoma of the jejunum causing superficial ulceration and with metastases in the mesenteric lymph nodes.

The recognition of plasmocytoma as a true neoplasm has been a controversial matter. Much of this is probably due to inconclusive knowledge of the nature, ori-

FIG. 4. The resected segment of jejunum opened along the antimesenteric border. The photograph shows the mucosal surface with the sharply circumscribed annular area of infiltration and ulceration.

gin and function of the plasma cell. Apparently it has a close relationship to the lymphocyte. Hellwig, in his review states, "the conception of the plasma cell as being a differentiated lymphocyte places the extramedullary plasma cell tumor in the disease entity of lymphoma." As in other lymphomatous lesions, difficulty arises in distinguishing between an inflammatory and a neoplastic process. According to Hellwig, the histopathological character of the lesion is not important in predicting the clinical course. He found the site and gross appearance to be of more prognostic significance. Thus a tumor of the conjunctiva may pursue such a benign course as to be considered inflammatory, whereas a tumor of identical histopathology located in the airways or lymph nodes may be highly destructive and metastasize widely. Further, if the tumor is localized, excision or irradiation, or both, may effect a cure. If the lymph nodes or bones are involved the prognosis is poor. Some cases, however, show recurrence years after the removal of a primary tumor.

With respect to the small intestine the histopathological classification of plasma cell tumor may be especially difficult. The issue is particularly clouded by the fact that collections of plasma cells can occur in chronic inflammatory conditions. Atypical forms of granulomatous lesions of the type seen in regional ileitis may be suggested. Certain features of our case and the cases described in the literature are of significance. The number of plasma cells, many of them in mitotic phases, appears too numerous to be explained on the basis of inflammation alone. In support of a neoplastic interpretation is the occurrence of plasma cells in such numbers with very few

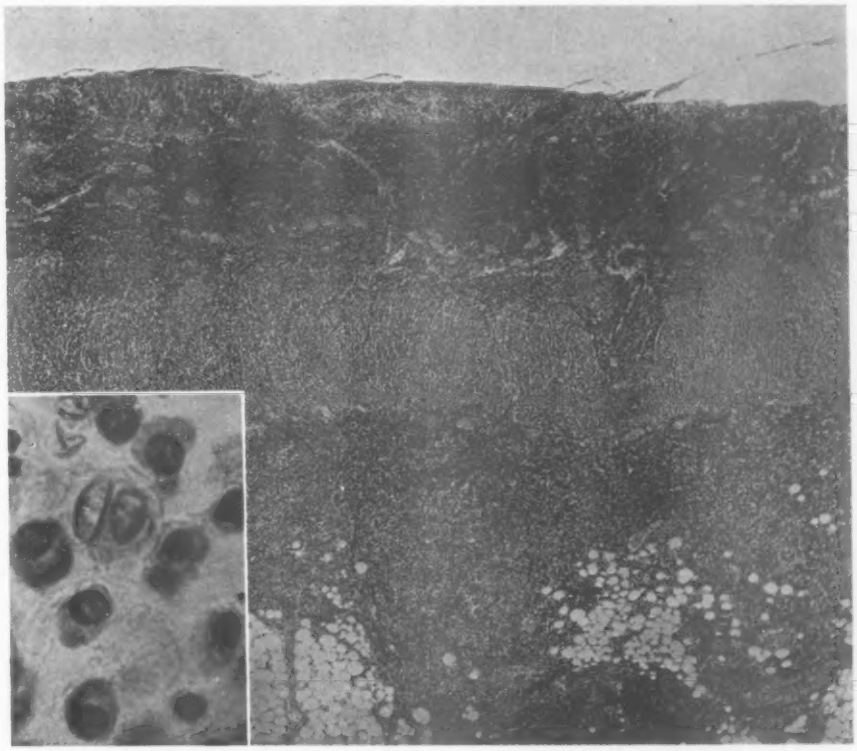

Fig. 5. Photomicrograph showing destruction of the mucosal glands and solid infiltration of all of the coats with masses of plasma cells which have also penetrated into the mesenteric fat. Inset shows the character of the individual cells.

lymphocytes, and without the presence of other inflammatory cells such as polymorphonuclear leukocytes, macrophages and other vascular elements commonly associated with inflammation. In Brown and Liber's case, groups of plasma cells were found within blood vessels without evidence of an enmeshing inflammatory thrombus. Of even more significance is the presence of large numbers of plasma cells within the regional lymph nodes justifiably interpreted as metastatic in nature. Hellwig stated further, "the extramedullary plasma cell tumor in spite of typical cell structure, may range from an entirely noncancerous growth to a cancer of high grade," the predicted course depending more upon the localization and gross appearance. It would appear from the above and other cases that plasmocytoma of the small intestine pursues the clinical course of a malignant tumor with a tendency to ulceration, multiple areas of involvement, and metastases to regional lymph nodes.

COMMENT

The small intestine is not a frequent site of malignant tumor. Swenson tabulated 131 cases of both benign and malignant tumors of the small intestine from the files of the Presbyterian Hospital. Only 49 of these were malignant. Roentgenographic methods of examination are playing an increasing rôle in the diagnosis of these lesions. The value of the spot compression roentgenogram in demonstrating destruction of mucosal folds and the presence of ulceration is borne out in our case. Beyond the destruction of the mucosa and its connotation of malignancy, one cannot be specific as to the type of lesion. In this respect one feature of our case is impressive. This is the presence of multiple areas of involvement. Lymphosarcoma may also involve the intestine at more than one level. We have reviewed 15 cases of lymphosarcoma of the small intestine from the files of the Presbyterian Hospital. In 4 of these the intestine was involved at more than one site. It is significant that all of these 4 were studied at autopsy and that of eight cases diagnosed by examination of surgical specimens or biopsies, none showed multiple areas of involvement. It would appear from this that earlier cases of lymphosarcoma are more likely to present single areas of involvement and that multiple areas occur as a later manifestation. In a recent review of lymphosarcoma of the intestines, Winkelstein and Levy[10] describe a case with involvement of the duodenum and several areas of proximal jejunum, and another case involving two areas in the terminal ileum. Occasionally other varieties of malignant neoplasm may show multiple areas of involvement. We have seen a case of metastases in the wall of the ileum, jejunum and one in the duodenum from an occult malignant melanoma. While multiple carcinoid tumors and metastatic implanting carcinoma occur, the lesions are usually too small to be detected roentgenographically. Adhesions may produce several narrow areas, varying in length, in which normal mucosal contours can be demonstrated by pressure roentgenograms. It may be necessary to differentiate malignant disease of the small intestine from narrowing due to inflammation. As suggested by Golden,[2] usually the constriction due to malignant disease is short, while that due to inflammation is longer. In many cases, however, the mucosal surface of the constriction as outlined by the barium is similar in both conditions. For example, a solitary tuberculous ulcer might produce a short constriction with destruction of mucosal folds. This would be indistinguishable from a primary malignant tumor. A short inflammatory narrowing cannot be differentiated with certainty from malignant disease, nor a long malignant tumor from an inflammatory process.

SUMMARY

We have presented the case of a thirty-five year old man who had repeated intestinal hemorrhages over a period of three years. A gastrointestinal roentgen examination before operation showed evidence of a

narrowing in the jejunum interpreted as evidence of malignant disease. A series done after operation showed two areas of narrowing in the jejunum. Laparotomy revealed six constricting lesions in the jejunum. Histopathological examination of one of these showed an enormous number of plasma cells infiltrating all walls of the jejunum and also the regional lymph nodes. This is interpreted as plasmocytoma of the jejunum with metastases in the regional lymph nodes. A discussion of the relevant pathological findings is presented. We have commented upon the multiple areas of involvement as of significance with respect to roentgenographic diagnosis.

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A STUDY OF THE RELATIVE IMPORTANCE OF THE CORTEX AND SPONGIOSA IN THE PRODUCTION OF THE ROENTGENOGRAM OF THE NORMAL VERTEBRAL BODY*

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FOR several years, we have attempted to explain, upon anatomical grounds, the various roentgen shadows of human vertebral bodies.[4,5] This paper is a continuation of work started in 1929 and has for its purpose the following considerations.

1. The relative "shadow values" of the cortex and of the spongiosa of the vertebral bodies.
2. An explanation of the transverse markings seen in the lateral roentgenogram of 10 to 20 per cent of human vertebral bodies.
3. The minimum size of a lesion in the spongiosa detectable roentgenographically.

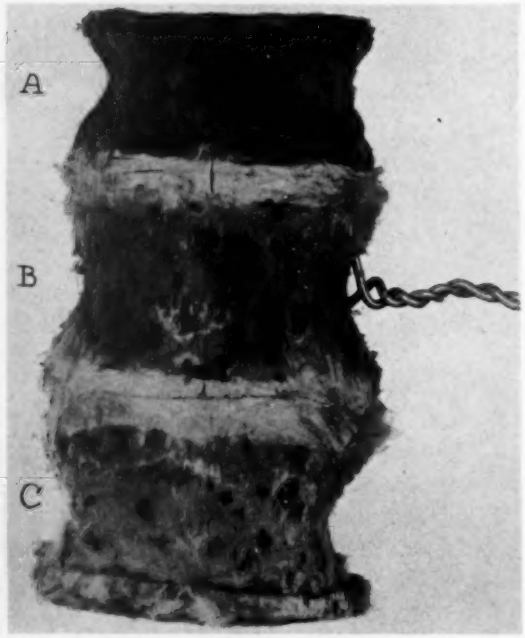

FIG. 1. Section of adult spine containing three lumbar vertebral bodies. *A*, soft tissue and cortex removed; *B*, soft tissue alone removed; *C*, soft tissue and spongiosa removed.

1. *"Shadow Values" of Cortex and Spongiosa.* The term "shadow values" is used to designate the relative importance of the cortex and spongiosa in producing the characteristic roentgenograms of vertebral bodies. Confusion exists as to the relative importance of these two components. Snure and Maner[3] contend that the cortex is largely responsible for vertebral roentgenograms, and that large portions of the spongiosa may be removed without being detectable. Lachmann,[2] in a study of the knee joint, finds that the cortex plays little part in the production of the roentgenogram. In order to determine the "shadow values" of vertebral body cortex and spongiosa the following experiments were made:

Fresh adult human lumbar vertebrae were obtained at necropsy and prepared as follows (Fig. 1): Three adjacent vertebrae were taken and labeled *A*, *B* and *C*. From *A*, the cortex was removed. From *B*, the soft tissues alone were stripped, this vertebra becoming a control for *A* and *C*. In *C* the spongiosa and soft tissues were removed, leaving but a cortical shell.

These vertebrae were immersed in the water phantom, and were roentgenographed under conditions designed to duplicate those obtained in a human subject of average size. A phantom consisting of an aluminum pail, of proved radiolucency, containing varying amounts of water, was used. The vertebrae were immersed at varying depths.

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For anteroposterior views, the pail was filled with water to a depth of 20 cm., and the specimen submerged to a depth of 8 cm. from the bottom (Fig. 2). For the lateral views, the pail was filled to a depth of 26 cm., and the specimen submerged to within 13 cm. of the bottom (Fig. 3). The exposure factors used were those for lumbar spine roentgenograms for a man of these anteroposterior and lateral dimensions.

A General Electric small focus tube, with rotating target, was used, the roentgenograms being made with the aid of a flat Bucky diaphragm. For the anteroposterior views, the exposures were at 3½ seconds, 50 ma., and 55 kv., the tube-film distance being 36 inches. For the lateral views, the exposures were at 7 seconds, 50 ma., and 65 kv., with the tube-film distance 34 inches. For the lateral views a medium sized cone was used.

As seen in Figures 2 and 3 the clear sharp outline present in *B* and *C* is lacking in vertebra *A*. However, the density of the bone in *A* and *B* is identical. The trabeculations are clearly visible in the vertebra from which the cortex has been removed, and cannot be distinguished from those of the control. Vertebra *C* (Fig. 2 and 3), however, presents an entirely different picture. The spongiosa of the vertebral body has been removed. Trabeculations are virtually absent; all that remains is a thin outline of the vertebra, the roentgen density of which is scarcely more than that of the water in which it is immersed except at its edges.

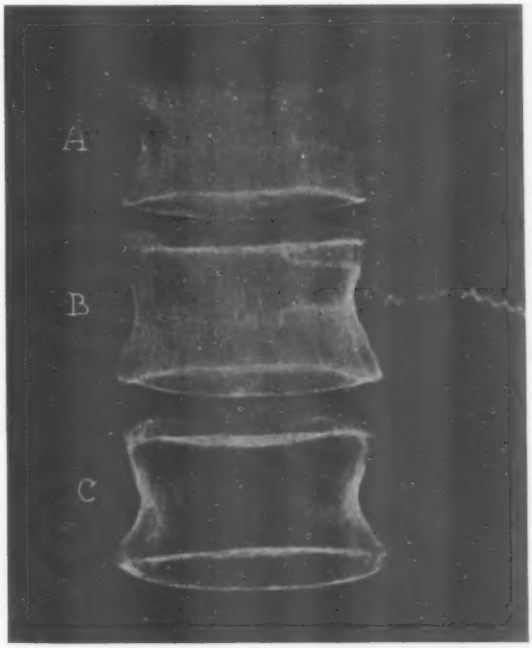

Fig. 2. Anteroposterior roentgenogram of vertebrae shown in Figure 1, made with bodies immersed in 20 cm. of water 8 cm. above the bottom of the container. *A*, soft tissue and cortex removed; *B*, soft tissue alone removed; *C*, soft tissue and spongiosa removed.

Fig. 3. Lateral roentgenogram of vertebrae shown in Figure 1 made with bodies immersed in 26 cm. of water 13 cm. above the bottom of the pail. *A*, soft tissue and cortex removed; *B*, soft tissue alone removed, *C*, soft tissue and spongiosa removed.

From this experiment the conclusion seems justified that the "shadow value" of the spongiosa is greater than that of the cortex in producing the characteristic roentgenogram of the vertebral body. It appears that the substance and detail of the roentgenogram are the result of the spongiosa, while the cortex contributes the sharp outline and a small amount of trabeculation which is almost entirely lost in the denser

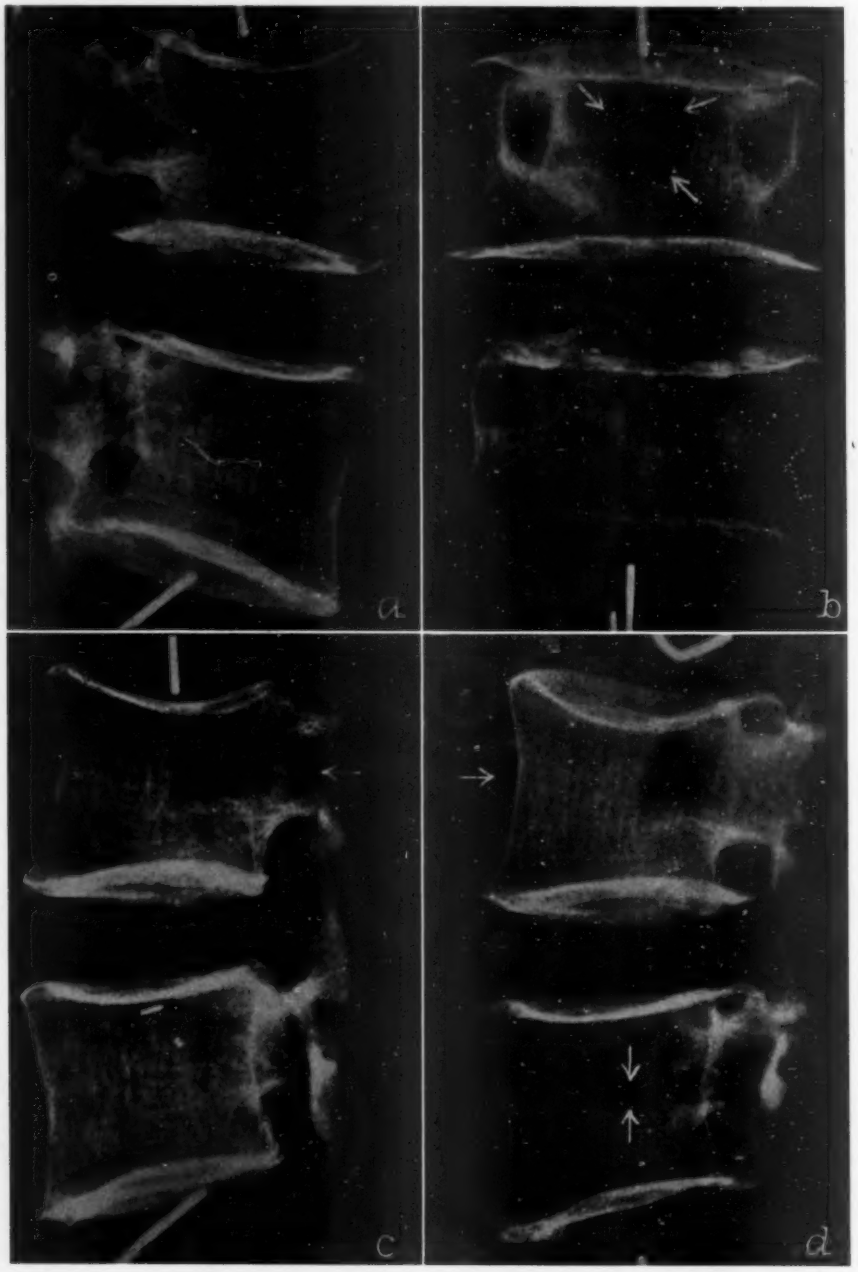

FIG. 4. Roentgenograms of lumbar vertebrae immersed in water. The roentgen technique is described in the text.

a, lateral roentgenogram of vertebrae before any artificial defects were made. Note that the vertebrae do not present "transverse markings."

b, anteroposterior roentgenogram of two lumbar vertebrae. A posterior defect was made in the spongiosa of the upper vertebra (arrows) and a cortical defect 5 mm. wide was made in the lateral wall of the lower vertebra (dotted outline).

c, lateral roentgenogram of the two vertebrae seen in *b*. Note that the transverse cortical defect cannot be seen but the defect in the spongiosa of the upper vertebra is indicated by an arrow.

d, lateral roentgenogram made after a central tunnel defect was made in the spongiosa of the lower vertebra. This defect, a zone of decreased density, may be seen clearly (arrows). The zone of decreased density seen in the upper vertebra (arrow) is due to a defect produced in the spongiosa.

and more pronounced markings of the spongiosa.

2. *Transverse Line.* In lateral roentgenograms of approximately 20 per cent of adult vertebrae there can be seen a transverse horizontal shadow extending through the center of the body. The presence of this shadow has frequently led to a diagnosis of fracture of the vertebral body.

Speculation upon the cause of the transverse marking has produced many explanations. Davis[1] considers the marking as due to diminished roentgen density the result of the venous sinusoidal system shown by us[4] to be present in the central area of the body.

In order that the cause and significance of this marking might be known the following examinations were made:

Two lumbar vertebrae were taken in which typical transverse markings were found absent in their lateral roentgenograms (Fig. 4, *a*).

It had been thought that a horizontal defect in the lateral walls of the vertebral body might explain the presence of the transverse marking. Consequently an artificial defect was made by removing a strip of cortex 5 mm. wide along one lateral wall. (This defect is clearly seen in the anteroposterior view in the left wall of the upper vertebra, Fig. 4, *b*.) Lateral roentgenograms of this vertebra taken after the cortical defect was made failed to show any shadow of lessened density (Fig. 4, *c*, lower vertebra). In view of the findings in this experiment it seems unlikely that a cortical defect is responsible for the production of the transverse markings seen so frequently in lateral vertebral roentgenograms in patients.

The same vertebra upon which the cortical defect was made was taken and by means of a small mastoid curette, introduced through the posterior foramina, an anteroposterior channel was cut through the center of the spongiosa. This channel was approximately 3 mm. in diameter. A lateral roentgenogram of this vertebra (Fig. 4, *d*, lower vertebra) now showed a transverse shadow of lessened density corresponding in position to the artificial defect in the spongiosa. (The actual defect is shown in the lower vertebra, Fig. 5.) The roentgen appearance is one of lessened density and corresponds to that of the "transverse markings."

Fig. 5. Cut surface of two lumbar vertebrae showing central defects made in spongiosa. The upper vertebra shows a posterior defect in the spongiosa which measures 12 by 8 by 12 mm. The lower vertebra shows a 3 mm. diameter horizontal defect made through the center of the spongiosa. Cortical defect of lower vertebra cannot, of course, be seen.

To show that defects in the spongiosa register in roentgenograms, a defect was made in the upper vertebra (Fig. 4, *b*, *c*, and *d*). This defect, as in the case of the central channel, was made by a mastoid curette introduced through the posterior foramina. The defect measured 12 by 8 by 12 mm. and was made in the posterior third of the spongiosa below the anteroposterior midline. This defect is seen clearly in all subsequent roentgenograms. (Its gross appearance is shown in Fig. 5—upper vertebra.)

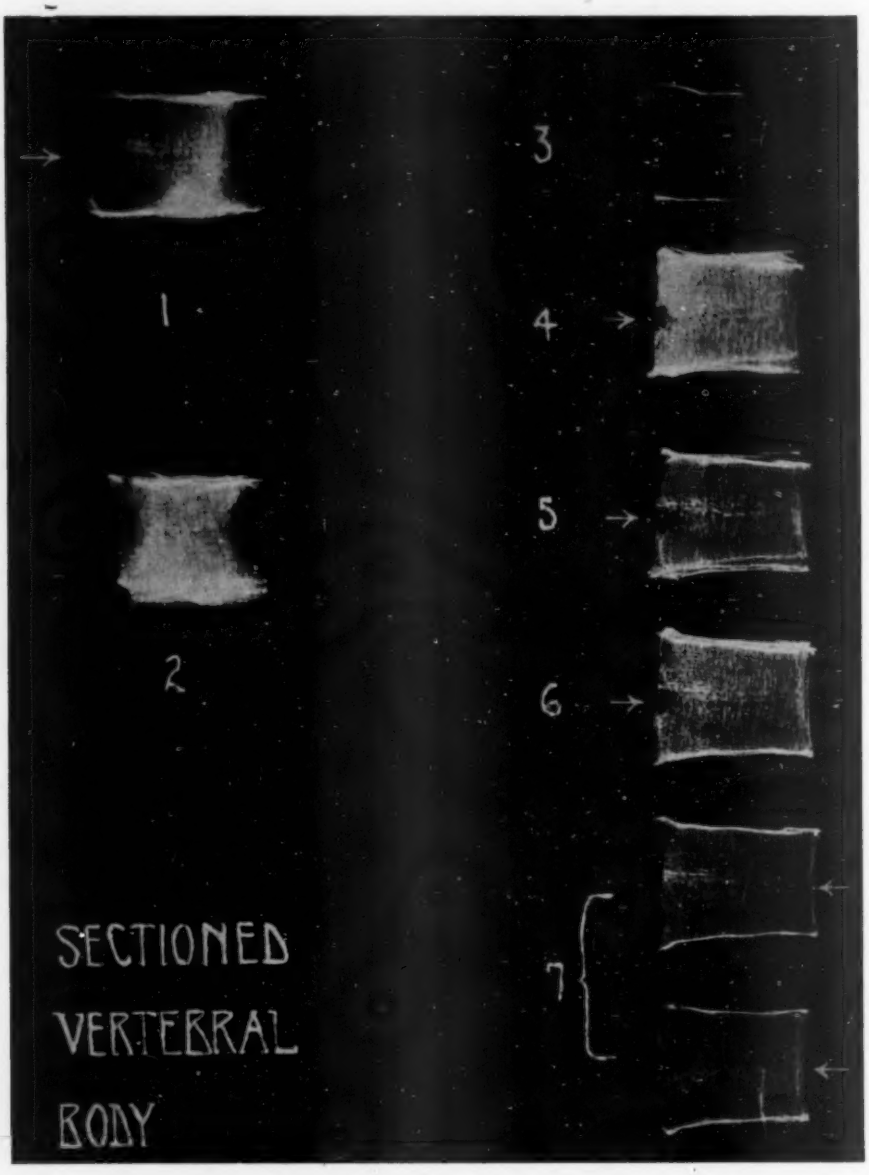

FIG. 6. Lateral roentgenogram of a vertebra taken in air. *1*, vertebra before sectioning—*showing transverse line (arrow)*; *2*, vertebra after sectioning; *3*, two lateral or cortical sections; *4*, five central sections; *5*, three central sections; *6*, two central sections; *7*, two central sections (separated).

In order to localize further the cause of normal "transverse markings" the following investigation was made:

A roentgenogram of a normal adult lumbar vertebral body was made in the lateral position (Fig. 6, *1*). The transverse markings are visible (arrow). This vertebra was then cut into seven parallel sections in its sagittal plane (Fig. 7). The sectioned vertebra was reconstructed and roentgenographed (Fig. 6, *2*). The transverse marking is not seen as well as in Figure 6, *1*.

The two lateral or cortical sections were removed and placed together. A lateral roentgenogram of these two sections failed to show the presence of the transverse marking (Fig. 6, *3*).

The five remaining sections were then

placed together and a lateral roentgenogram showed the presence of the central transverse marking (Fig. 6, *4*).

The next two lateral sections were removed and the remaining three central sections showed in the lateral roentgenogram the transverse marking more clearly than in the preceding roentgenograms other than that of the intact vertebra (Fig. 6, *5*).

The more lateral of the three sections was removed and the two central sections continued to show in the lateral roentgenogram the transverse marking (Fig. 6, *6*).

The two central sections were examined separately and each showed in the lateral roentgenogram the transverse marking (Fig. 6, *7*). In neither section was the marking as clear as when the two sections were examined in apposition.

From the foregoing investigation it can be concluded that the "transverse" marking seen in lateral roentgenograms of the intact vertebral body is produced by the peculiar structure of the central area of the body.

More detailed examination of the "transverse" marking, especially that seen in the roentgenogram of the two central sections, shows four characteristics.

1. Posterior conical notch shadow.
2. Central area of lessened density.
3. Two narrow bands of increased density, one bordering the area of lessened density above, the other below.
4. Decrease in the number of cortical bone trabeculae extending across the area of lessened density.

Explanation of these characteristics is made upon an anatomical basis.

As shown in a previous report[4,5] the posterior conical notch shadow is produced by lateral projection of the posterior vascular foramen.

The central area of lessened density corresponds in location and size to the central reservoir of the sinusoidal system shown previously to exist within the central structure of the vertebral body.

The two narrow bands of increased density bounding the central area of lessened density above and below correspond to horizontal trabeculae present in these sites. These bone septa approach the texture of cortical bone plates. Posteriorly they are continuations of the walls of the posterior foramen. As they extend anteriorly they diminish in thickness and breadth and consequently in roentgen density.

Fig. 7. Anterior view of lumbar vertebra sectioned in the sagittal plane. This is the vertebra that is shown in Figure 6.

In view of the foregoing, it can be definitely stated that the transverse markings seen in the lateral roentgenograms of many normal adult human vertebral bodies are due to the presence of an especially well developed sinusoidal reservoir. This finding is in general agreement with Davis' conclusions. Davis,[1] however, assigns to "blood vessels" and "blood vessel channels" within the bodies of the vertebra the causative role. We state that sinusoidal spaces and the central sinusoidal reservoir present in the bodies are responsible. The difference between these two explanations is one of histologic interpretation of the structures concerned.

Parenthetically, it may be stated that we believe that lateral roentgenograms of all normal vertebral bodies would show transverse markings if the exposure factors were correct or if the vertebra could be examined outside of the body. In practice one observes these markings more often in the

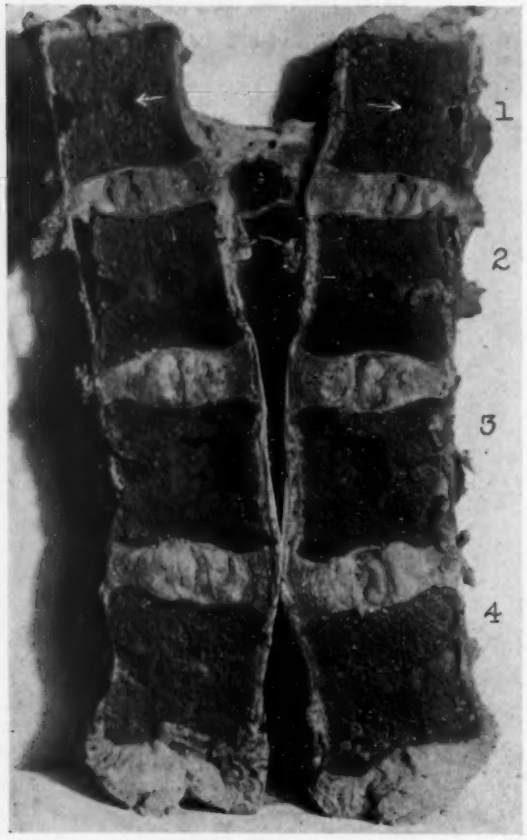

FIG. 8. Sagittal bi-section of four lumbar vertebrae, hinged by fibrous tissue at their anterior surfaces. The first three vertebrae, from above down, have had cuboidal defects made in the central portion of the spongiosa. Size of defects: *1*—3 by 4 by 5 mm.; *2*—4 by 6 by 9 mm.; *3*—9 by 10 by 10 mm. The conical defects present in the posterior portions of all vertebrae are normal and are the posterior foramina or "notches."

dorsal vertebrae where roentgen-ray contrasts are greater. Overlying tissues and less well developed central sinusoidal reservoirs tend to lessen the definition of the transverse markings in lateral roentgenograms.

3. *Minimal Size of Vertebral Body Defects Recordable by Roentgenography.* The next problem is concerned with determining how small a defect made in (*a*) cortex and in (*b*) spongiosa will register upon roentgenograms taken under experimental conditions approximating the normal.

A section of normal adult human spine composed of four lumbar vertebrae was bivalved in the sagittal plane. Defects were made in the spongiosa of the three upper vertebrae and a cortical defect in the lower vertebra (Fig. 8 and 9). The two halves of the section were approximated and fastened together. Roentgenograms were taken with the vertebrae immersed in water in accordance with the technique described in the first part of the paper.

(*a*) Cortical Defects. As shown previously, a groove cut in the cortex of the lateral wall of a vertebral body can be recognized in an anteroposterior but not in a lateral roentgenogram (Fig. 4, *b* and *c*).

The cortical defects made in the lateral walls of the lowest vertebra, as shown in Figure 9, measured 10 by 10 mm. These defects, though large and superimposed, failed to be shown in either anteroposterior or lateral roentgenograms (Fig. 10, *4*).

(*b*) Spongiosal Defects. The defect made in the spongiosa of the uppermost vertebra

FIG. 9. External view of vertebra shown in Figure 8. On the lowest vertebra cortical defects measuring 10 by 10 mm. have been made in the lateral walls. These defects are so placed as to superimpose when the bisected column is closed.

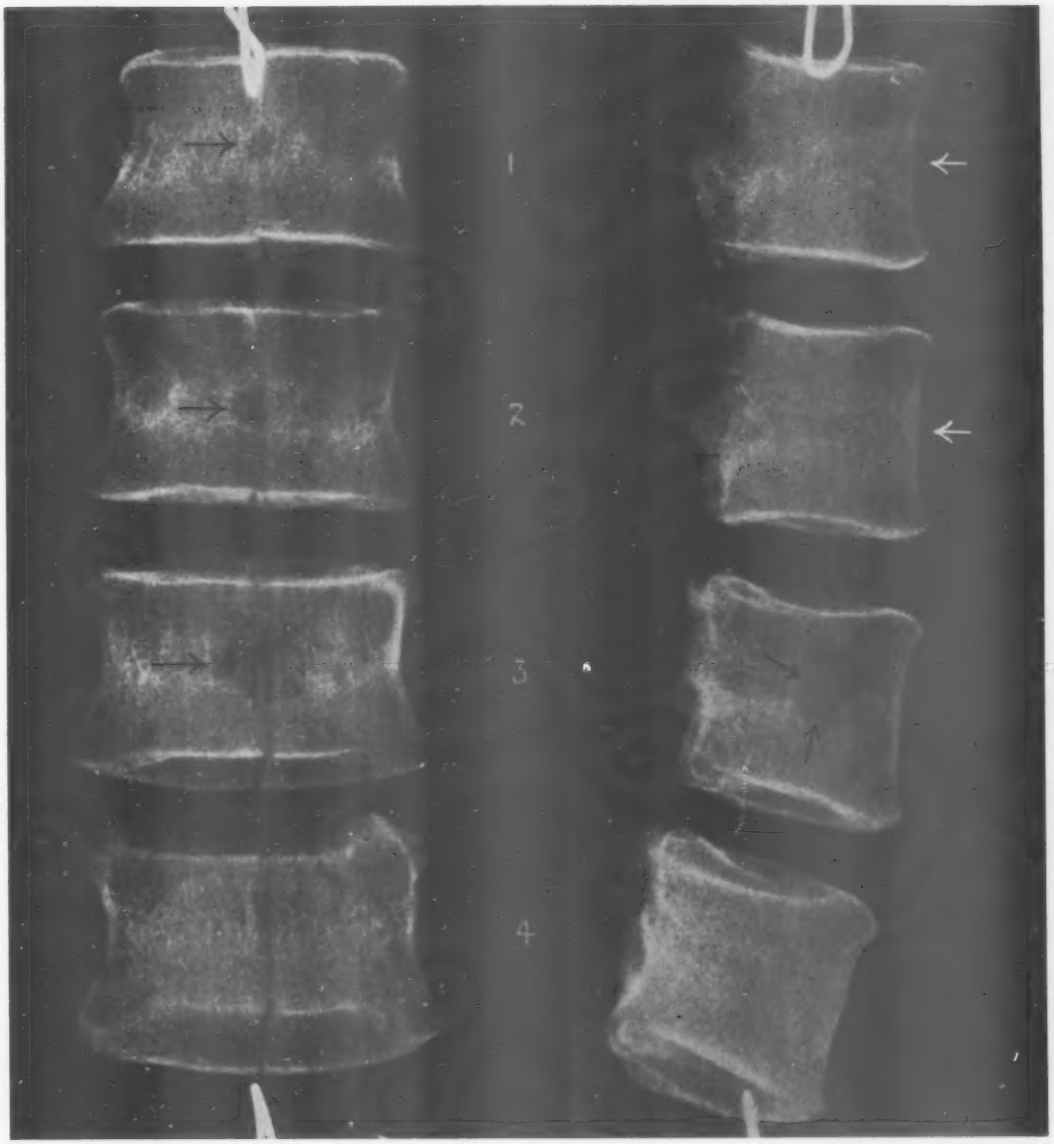

Fig. 10. Anteroposterior and lateral roentgenogram of the vertebra shown in Figures 8 and 9. Vertebrae immersed in water.

(*1*) measured 3 by 4 by 5 mm. That of *2* measured 4 by 5 by 9 mm. and *3*, 9 by 10 by 10 mm.

In the anteroposterior roentgenogram the defects in all the upper three vertebrae are apparently shown (Fig. 10). In the case of vertebrae *1* and *2* the defects, as shown in Figure 8, are on the same axis as the posterior foramina. This positional arrangement results in shadow intensification in the anteroposterior roentgenograms.

The central defect in vertebra *3* is conclusively shown in the anteroposterior roentgenograms of this vertebra.

In the lateral roentgenogram of these vertebrae the central defect is clearly seen in vertebra *3*. Knowing that a defect is present in vertebra *2* a corresponding shadow can be seen in its roentgenogram. A faint central shadow can be seen in the lateral roentgenogram of vertebra *1*.

It is highly questionable whether the

central shadows in the lateral roentgenogram of vertebrae *1* and *2* would be detected were it not known that defects in the spongiosa of these vertebrae were present.

In conclusion, it can be said that large defects of the lateral cortex are not recorded in roentgenograms, and that much smaller defects of the spongiosa are clearly recorded by roentgenograms especially when they are superimposed upon anatomic shadows of decreased density.

These studies explain why in many instances it is difficult to demonstrate metastatic lesions whether of malignant or infectious origin even in the presence of strong clinical evidence that a lesion may be present. Likewise, in practice one not infrequently has to deal with confusing shadows of other structures.

SUMMARY AND CONCLUSIONS

A series of experiments is described in which the following problems were investigated:

1. The relative importance of the cortex and spongiosa in the production of the roentgenographic shadow pattern of the normal vertebral body.

2. The source of the "transverse line" seen in a high percentage of normal vertebrae.

3. The minimal size of vertebral body defects recordable by roentgenography, and whether such defects are best visualized when present in cortex or spongiosa.

The following conclusions were reached:

1. The spongiosa is the more important component in the production of the roentgenographic shadow pattern of the normal vertebral body.

2. The "transverse line" is due to the presence of a well developed sinusoidal reservoir located within the spongiosa, and the cortex plays no part in the production of this marking.

3. Large defects of the lateral cortex are not recorded in roentgenograms, and much smaller defects of the spongiosa are clearly seen.

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PSEUDARTHROSIS, SYNCHONDROSIS AND OTHER ANOMALIES OF THE FIRST RIBS*

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THE roentgenologist sees many variations and anomalies of the ribs, but only rarely in connection with any symptoms. Occasionally, cervical ribs are found, but scarcely ever are they associated with neurological symptoms. Other anomalies of the ribs, especially the first ribs, only sporadically require diagnostic attention. The roentgenologist may erroneously make an unsupportable diagnosis, however, if he is not familiar with the common developmental irregularities which are usually not associated with functional defects or actual disease.

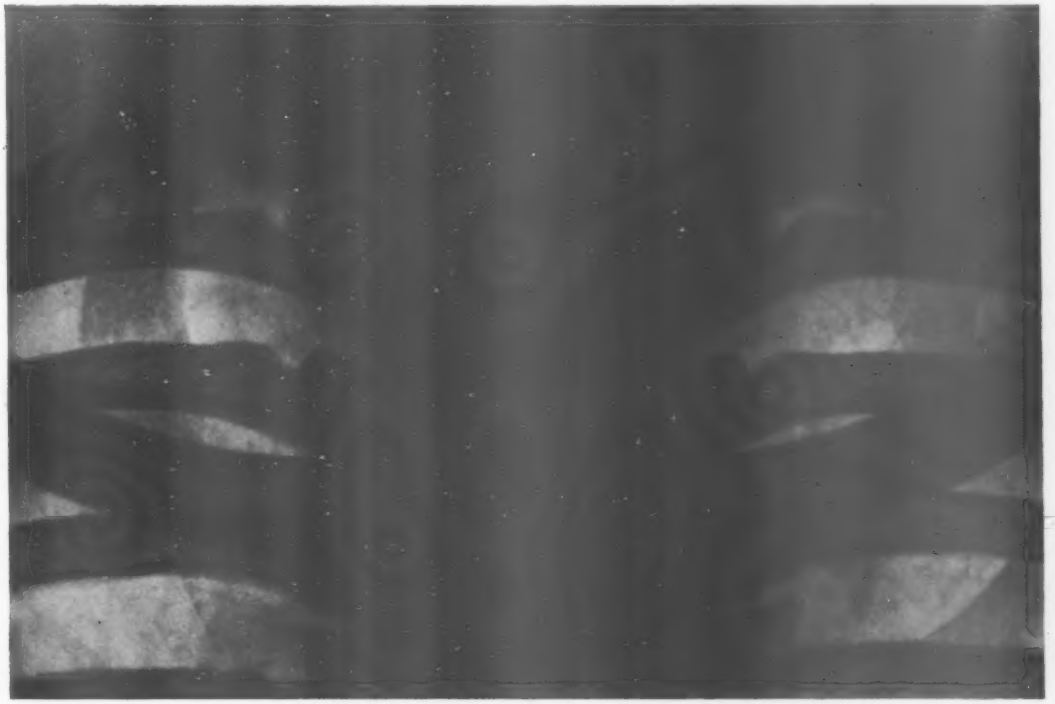

FIG. 1. Anterior portion of the left first rib is hypoplastic.

ANOMALIES

Steiner[13] found rib abnormalities in only 0.15 per cent of 38,105 cases, and of these, 35 per cent were cervical ribs. Anomalies of the first rib were found by Todd[14] to occur in something like 1 per cent. Asymmetry of development is probably the most frequent normal deviation of the first ribs (Fig. 1). Next is failure of ossification of the anterior portion of the first rib, usually forward of the scalene tubercle (Fig. 2). Todd believed this resulted during embryological development from undue compression of the subclavian vessels in the groove which they occupy in the upper aspect of the first rib. Ribs so deformed are short and sometimes simulate cervical ribs, necessitating examination of the cervical and dorsal spine in order to make cer-

* Nothing in this report is to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

FIG. 2. Anterior portions of both first ribs are hypoplastic.

tain of the diagnosis. Partial instead of complete failure of ossification of the anterior portions of the first ribs is occasionally seen and the irregular ossification then observed is usually close to the manubrium, forming an incomplete sternoclavicular joint. Bifid first ribs are among the rarest unnatural aberrations, but incomplete foramen-like defects, suggesting a prebifid stage is seen instead near the costochondral junction. Complete absence of the first rib has been described by Dreyfus-le Foyer, Augé and Brunet,[5] but no explanation of this defect was offered. Fusion of part or all of the first rib with the second rib is among the more frequently encountered peculiarities

FIG. 3. Fusion of the right first and second ribs.

(Fig. 3). Some authors have advanced theories linking these inconstant rib mutations to the evolution of disease in the underlying lungs and pleura, particularly tuberculosis. Since giving this hypothesis our close attention, never has a clear association been observed between tuberculosis or other disease in the upper lobes and these first rib anomalies.

CONGENITAL SYNCHONDROSIS

Andersen[2] covered rather completely the different normal modifications of first rib development and included a group of pseudarthroses of cervical and first thoracic ribs which more frequently than the other anomalies make an embarrassing demand on the roentgenologist in differentiating them from simple or pathological fractures. Some illustrations of these odd cases from our own experience are shown in Figures 4 to 8. These pseudarthroses tend to occur in the posterior third of the first rib. Von Sassen[12] believes they represent fractures due to muscle traction with subsequent pseudarthrosis. He disagrees with Frank-Pittowa[6] and Pickhan[11] who attributed this condition to a developmental anomaly akin to the avian costal articulation. Frank-Pittowa reported the case of an eighteen year old student with no history of injury who had a joint space dividing the first rib. The line of rarefaction had smooth contours and no callus was present.

This case is similar to ours (Fig. 5) in a patient who had no injury and no symptoms in this area. Practically the same findings were observed in the case reported by Pickhan. These cases have in common (1) no history of injury, (2) no callus, (3) smooth edges and surfaces along the plane of dissolution and (4) no abnormal changes in the bone. For these reasons, it hardly seems likely that an old ununited fracture with pseudarthrosis is the correct explanation. A congenital synchondrosis would seem to be a more appropriate designation. Similar synchondroses are seen occasionally between the first and second ribs (Fig. 4).

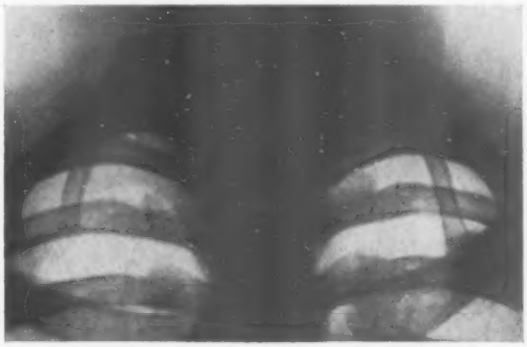

Fig 4. Bilateral synchrondroses of first and second ribs.

Fig. 5. Synchondrosis of the left first rib in nineteen year old male. No history of injury and no symptoms were present.

PSEUDARTHROSIS

Failure to obtain a history of injury is in itself no proof against the existence of a fracture in a rib. So-called spontaneous fracture of a rib is not unfamiliar to roentgenologists, especially in patients with a violent cough, even in the absence of obvious lung disease. While these fractures may not be recognized at the time of their occurrence, the formation of a "lump," tender to touch and locally painful to the patient, especially when coughing, usually leads to a roentgen examination which almost invariably discloses callus formation. The roentgen appearance of such an incom-

FIG. 6. Pseudarthrosis not unlike an ununited fracture of the left first rib in a patient who gave no history of an injury. No symptoms were present, this finding having been incidental.

pletely united fracture is entirely different than the synchondrosis shown in Figure 5. Unrecognized "spontaneous" fractures of the first rib do seem to occur and by the time they are finally revealed in a roentgenogram, a pseudarthrosis may have formed.

In a recent examination of a thirty-one year old male, a serofibrinous pleurisy was found. A pseudarthrosis was discovered in the homolateral first rib and the possibility of a pathological fracture due to metastatic malignancy had to be eliminated before the diagnosis could be established. The patient could remember no injury and never did he have any complaints referred to this area (Fig. 6).

In another male, aged nineteen, a pseudarthrosis of the left first rib was found incidentally during an examination of his lungs. He could furnish no history of injury and he had no symptoms (Fig. 7).

Aitken and Lincoln[1] believe that fracture of the first rib is possible as the result of muscle pull by the scalenus anticus. They quote the case of a twenty-nine year old male who carried a 50 pound load on his head up a ladder. An inadvertent jerk of the head caused a snap to be felt in his neck. Some pain developed, but this lasted only two or three days. While making up a bed twenty-six days later, the snap in the left supraclavicular area recurred followed by tingling in the fourth and fifth fingers. A fracture of the first rib was then found by roentgen examination, approximately at the site of the scalenus tubercle. The irregular fracture line and the presence of slightly calcified callus necessitated no differentiation from a congenital synchondrosis. Remarkable is the fact that fracture of the first rib, so well protected anatomically, can be fractured apparently by muscle pull, as is not infrequently the case in fracture of the lower ribs.

An excellent review of fractures of the first rib is to be found in Breslin's report[3] of 27 cases which included 22 gathered from the literature and 5 of his own. Re-examining the details of each case, there is little question about the diagnosis in those instances where there was direct and often violent trauma. Many of these suffered

FIG. 7. Pseudarthrosis of the left first rib in nineteen year old male. No history of injury and no symptoms were present.

Fig. 8. Bilateral pseudarthroses first ribs. No history of injury and no symptoms were present.

complications such as fatal hemorrhage from torn subclavian vessels, puncture of the lung, local abscess formation and the occurrence of Horner's syndrome. But conclusive evidence of fracture is not always advanced in other cases where the injuries were mild or trivial such as a fall while walking or a fall from a low height. In 1 case, that of a female, aged sixty-eight, the fracture was thought to have occurred during sleep. Two cases could furnish no history of an injury. Unfortunately, roentgen findings were not available in all the reports. In the obvious fractures of the first rib, worthy of note was the frequency of a sensation of sticking pain in the supraclavicular area and tingling in the fourth and fifth fingers. These symptoms were absent in those cases which presented no history or injury or which revealed indefinite evidence of fracture.

Cohen[4] reported isolated fractures of the first rib in 3 cases among 3,000 examinations of selectees' chests. In 1 of these cases, there was no history of injury and the appearance in the roentgenogram was that of a congenital synchondrosis (like that in Fig. 5). In the other 2 cases where fractures seemed to have occurred following injuries, even though the subjects sought no treatment, the roentgenograms revealed pseudarthroses.

Kohlbach's case[8] of a forty year old man is an example of the difficulty in differentiating a fracture pseudarthrosis from a congenital synchondrosis of the first rib. His patient suffered a contusion of the shoulder. The roentgen examinations of the shoulder revealed nothing abnormal, but a "joint formation" of the right first rib was found. He correctly recognized this not to be a fracture.

BILATERAL PSEUDARTHROSES OF THE FIRST RIB

Bilateral fracture of the first rib has been described rarely. Oldfield[9] reported a case of a seventy year old man who had been in a bus accident, but who could not remember exactly what had happened. All that he could recall before losing consciousness was that just prior to the accident, he was sitting in the bus with his left elbow on the window ledge. In the hospital later, he conplained of pain in the lower part of the neck when he coughed. The roentgen examination revealed a transverse fracture of

both first ribs in a similar position on each side.

Another case of bilateral fracture of the first rib was recorded by Outland and Hanlon[10] in a male twenty-one years old who was pinned in the rumble seat of an automobile when the car crashed into a post. He complained of backache, inability to move his left arm and difficulty in breathing. The roentgenogram showed fractures of the vertebral ends of both first ribs with no displacement of the fragments. The nature of the injury and character of the lines of dissolution in the ribs leave little room for doubt of the correctness of the diagnosis.

In Friedl's case[7] of isolated bilateral first rib "fracture," it is hard to determine whether fracture pseudarthroses or congenital synchondroses were present. The history of injury was indefinite. His patient, a twenty year old recruit, fainted during a march and fell to the ground. The roentgenogram was made three weeks after the accident, somewhat early for the formation of fracture pseudarthroses.

In our case, the man sustained fractures of the left clavicle and left fifth and sixth ribs three years prior to our examination which was made primarily of his lungs. Bilateral pseudarthroses of the first ribs were found. The patient could remember no injury to these areas and he had no symptoms referable to these parts (Fig. 8). Thus it seems that bilateral "spontaneous" fractures of both first ribs are possible without immediate recognition by the patient or his physician.

SUMMARY

The usual anomalies of the first rib are briefly reviewed. Congenital synchondrosis is demonstrated because of its similarity to pseudarthrosis following ununited fracture. Muscle pull seems to be a possible cause of fracture of the first rib as in the lower ribs, and such fractures may occur without immediate recognition. Later, however, they may be observed incidentally in roentgenograms of the lungs. These pseudarthroses may be found rarely in both first ribs. One such case is cited here in addition to a review of three cases previously reported by others. Most anomalies of the first rib are not clinically significant, but the differential diagnosis between congenital synchondrosis, fracture pseudarthrosis and pathological fracture may be important and yet not easily made if there is an unsatisfactory history of injury or if metastatic malignant disease is suspected.

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EARLY RECOGNITION OF ENDOCRINE DISORDERS IN CHILDHOOD BY ROENTGENOGRAMS OF THE WRIST TO DETERMINE THE "OSSIFICATION INDEX"

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SUCCESSIVE studies of the onset of ossification in the epiphyses of the long bones and the primary centers of the small bones of the extremities have attempted to construct a time table for the scheduling of these events in normal growth. All of these studies have tried to determine the normal stages but have been forced to resort to various computations of averages when confronted by a relative precocity in girls and healthy variations in both sexes. As a result, the notations that have been made during each series of observations have contributed to a general picture without producing specific standards for the clinician.

The article presented by Pyle and Sontag[15] appears to include about as accurate a summary of the stages of development as can be compiled from closely grouped serial roentgenograms of carefully selected normal children. This tremendous undertaking has resulted in a tabulation which gives the "mean" age for the appearance of each ossification center together with a "coefficient of variability" for each in boys and girls as separate groups. In spite of this excellently controlled study, the reader still does not obtain a simple usable figure without laborious comparison of his clinical material with these tables of variables. These findings, compared with those of other less detailed studies, show a reasonably close agreement and provide the material for a convenient simplification.

The clinician's purpose is to obtain from this information a practical application to his work with children. Francis[9] has stated reasonably that the definite sequence for the appearance of centers of ossification may be interrupted by metabolic or constitutional disturbances, and that these delays may be the earliest indication of these subclinical conditions. He also states that sickness at the time any specific center is scheduled to appear may also cause delay. Pyle and Sontag,[15] in the study mentioned, apparently found no evidence to substantiate this last claim although their series of constitutionally normal children must have been subject to transient illnesses. Clark[4] has demonstrated that from the age of one year to the onset of puberty roentgen examination for the determination of the stage of ossification is the most accurate measure of the metabolic rate and is of great value in the study of chronic endocrinopathies even after puberty. Other authors[7,17,18] have also emphasized the relation between endocrine disturbances and the easily obtainable facts about ossification. It has been demonstrated that subsequent roentgenograms may be relied upon to show the effectiveness of endocrine therapy even when the clinical features are too vague to show minor changes.[4]

It is impossible to place all of these observations in a readily usable form for routine clinical practice in terms of mathematical averages and coefficients of variability. The whole field of study must be reduced by several arbitrary moves which may admittedly be scientifically inaccurate but, properly understood, may be extremely useful. The first of these moves is the acceptance of one part of the anatomy as an indicator of the conditions elsewhere.

As pointed out by Clark,[4] it is reasonable to accept roentgenograms of the wrist as showing the variations in a region which is a good index to the extent of departure

from the usual rate of ossification throughout the entire body. This plan has been also accepted by Shelton.[17] Francis[9] feels that this area with so many primary centers is more sensitive to metabolic disturbances than regions with secondary epiphyseal centers only. For these and other ossification, the pediatrician or the roentgenologist must make a second dogmatic move to decide upon what is to be called the limit of normal. Greatest interest will be attached to cases where the ossification is delayed and attention will be most often focussed upon the latest appearance which

TABLE I

SUMMARY OF STUDIES OF OSSIFICATION CENTERS IN THE WRIST

	Quoted from Shelton [17]																		
	1898 Poland (13)	1909 Rotch [16]	1919 Knox [11]	1921 Baetjer [2]	1924 Cohn [5]	1924 Englebach [7]	1931 Allen [1]	1931 Shelton [17]	1929 Patterson [12]	1926 Dorland [6]	1931 Camp [3]	1933 Hodges [10]	1933 Pryor [14]	1936 Clark [4]	1939 Francis [9]	1942 Flecker [8]	1943 Pyle & Sontag [15]	EARLIEST APPEARANCE OF OSSIFICATION IN THE CENTERS AS JUDGED BY INSPECTION OF ALL REPORTS	LATEST APPEARANCE OF OSSIFICATION IN THE CENTERS AS JUDGED BY INSPECTION OF ALL REPORTS
CAPITATE CENTER	8 mos.	1st yr.	1st yr.	1st yr.	6 mos.	4 mos.	6 mos.	4 mos.	6 mos.	3-6 mos.	4-6 mos.	2-10 mos.	3-8 mos.	1st yr.	2 mos.	1st yr.	0-2 mos	Birth	6 mos.
HAMATE CENTER	1st yr.	1st yr.	1st yr.	1st yr.	6 mos.	5 mos	1st yr.	5 mos	6 mos	4-7 mos.	4-6 mos.	2-10 mos.	3-8 mos	1st yr.	2 mos.	1st yr.	0-3 mos.	Birth	7 mos.
DISTAL RADIAL EPIPHYSIS	2 yrs.	2 yrs.	2 yrs.	2 yrs.	6 mos.	8 mos.	1½ yrs	8 mos.	—	—	6 mos.	6-10 mos.	8-14 mos.	1-2 yrs.	7 mos.	1st yr.	9-18 mos	6 mos.	2 yrs.
TRIQUETRUM CENTER	3 yrs.	3 yrs.	3 yrs.	3 yrs.	3 yrs.	3 yrs.	2-3 yrs.	3 yrs.	3-4 yrs.	2-3 yrs.	2-3 yrs.	½-3 yrs.	1-3 yrs.	3-4 yrs.	10 mos	3-4 yrs	2-4 yrs.	1 yr.	4 yrs.
LUNATE CENTER	4½ yrs.	4 yrs.	4 yrs.	4 yrs.	4 yrs.	4 yrs.	3-4 yrs.	4 yrs.	4-5 yrs.	3-4 yrs.	4-6 yrs.	3-4 yrs.	3-5 yrs.	4-5 yrs	2 yrs.	3-4 yrs.	2-4 yrs.	2 yr	5 yrs.
NAVICULAR CENTER	5 yrs.	5 yrs.	5 yrs.	5 yrs.	4-5 yrs.	5 yrs.	4-5 yrs.	5 yrs.	5-6 yrs.	4-5 yrs.	5 yrs.	5-6 yrs.	4-6 yrs.	6-7 yrs.	4¾ yrs.	4-6 yrs.	4-5 yrs.	4 yrs.	6 yrs.
LESSER MULTANGULAR CENTER	5-6 yrs.	6 yrs.	6 yrs.	6 yrs.	5-6 yrs.	6 yrs.	5-6 yrs.	6 yrs.	5-6 yrs.	4-5 yrs	5 yrs.	5-6 yrs.	4-6 yrs.	6-7 yrs.	4¾ yrs.	4-6 yrs.	4+5 yrs.	4 yrs.	7 yrs.
GREATER MULTANGULAR CENTER	5-6 yrs.	5 yrs.	5 yrs	5 yrs.	5-6 yrs.	5 yrs.	5-6 yrs.	5 yrs.	5-6 yrs	4-5 yrs.	5-8 yrs.	5-6 yrs.	4-6 yrs.	5-6 yrs.	4⅛ yrs.	4-5 yrs.	4-5 yrs.	4 yrs	7 yrs
DISTAL ULNAR EPIPHYSIS	6-7 yrs	5-7 yrs.	4 yrs.	4 yrs.	6-7 yrs.	6 yrs.	6-7 yrs.	6 yrs.	—	—	7 yrs.	6 yrs.	6-8 yrs.	6-7 yrs.	—	5-6 yrs.	6-7 yrs.	5 yrs.	7 yrs.

obvious reasons related to convenience, the stand may be taken that examinations of the wrist alone will be sufficient to fill the clinician's needs. It is then a simple matter to devise a technique for taking a roentgenogram whenever needed during the usual rapid routine examination of a pediatric clinic.

Having decided to take roentgenograms of the wrist for the study of the rate of may be allowed each center in the off-the-average but still normal child. The determination of these limits must evolve from the reports of all those who have efficiently studied the matter. Such a comparison of data from seventeen readily available sources is presented in Table 1. Whatever criticism there may be concerning the methods by which these investigators arrived at their conclusions and whatever

chance there may have been that abnormal cases crept into their studies of the supposedly normal, the general review of their combined findings presents an authoritative picture. Fortunately, the application

The application of this arbitrary standard, as has been suggested, lies in the field of metabolic disorders. Clark[4] has presented a review of the functions of the different endocrine glands and their relation to ossi-

Fig. 1.

of these figures in actual practice requires no fine differentiation because only the extremes are of real significance. It is therefore practical to list the figures presenting the outside limits, the earliest and the latest that each center of ossification may normally appear, and because of the interest in the extremes only, a wide margin may be allowed and sex ignored in the construction of a combination of figures which will embrace all of the variable reports without significant error (Table 1).

fication. He concluded that the important hormones influencing skeletal growth are the thyroid hormone, the anterior lobe pituitary growth hormone and the sex hormone. In the cases which Clark uses as examples all were apparently obvious endocrine disorders by inspection except one. This presented a subclinical hypothyroidism of the type which does not show the textbook symptom-complex expected for juvenile myxedema. This case presented simple abnormalities of behavior such as

shyness, backwardness in school and lack of normal interest in play. A sleepiness and mental sluggishness is said to often develop before the condition is recognized as more than a temperamental peculiarity. It is in just such cases as these that roentgen examination of the wrist proves its value. By study of the rate of ossification and the discovery that the appearance of the centers has been delayed, the need for substitution therapy will be proved and the progress of recovery under treatment observed.

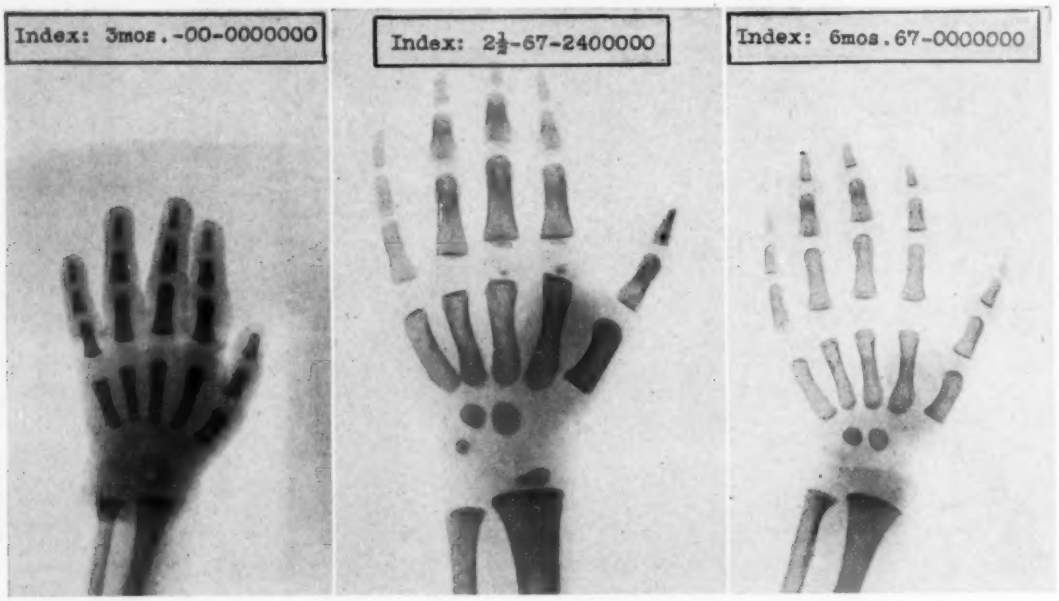

FIG. 2. Reproductions of roentgenograms taken during a pediatric clinic. A numerical description of the centers present is given in the form of the proposed "ossification index." Normal development is present in each case because all centers are present up to the actual age.

OSSIFICATION INDEX

For rapid evaluation of the stage of ossification shown in any roentgenogram of a developing wrist, the use of a group of significant figures as an "ossification index" is proposed. As has been stated, this idea has been reached by a series of dogmatic short-cuts, first limiting the region of study to the wrist and then adopting a set of arbitrary age extremes for the appearance of the centers of ossification in that region. The taking of these liberties seems justified by the purpose back of it, but to accept this as an index one must first accept the logic of the short-cuts. The pediatrician desires an indication of the extremes which, when discovered, can be subjected to further analysis. For his greatest convenience and as a quick evaluation and record of the stage of ossification, the figures chosen for the appearance of the centers may be posted in their chronological order as an index in which the key to interpretation is the actual age of the patient.

A diagrammatic representation of the order and the latest appearance of the ossification centers will assist in the computation of the index (Fig. 1). The index itself for the detection of delayed ossification is constructed by setting down the actual age followed by the figures for the centers actually present. These are placed in their chronological order and zeros substituted if any center has not yet appeared. A separation is made with hyphens between the figures representing months and those representing years. Thus the normal index for the full complement of centers at the age of seven years becomes 7-67-2456777

(Fig. 1). When the actual age is less than seven, all centers up to that age should be present. For example; at the age of three: 3-67-2000000. With figures like these on the patient's record any deviation from the normal can be obvious without further reference to the roentgenogram.

It will also be seen that since this index is composed of figures representing the *latest* assigned for the centers *up to the actual age* regardless of how many more may be present. Any index arrived at by inspection of a roentgenogram and found not to contain all of the figures up to the actual age of the patient is pathological.

Inasmuch as the discussion of the appearance of the ossification centers of the wrist has omitted mention of the pisiform bone

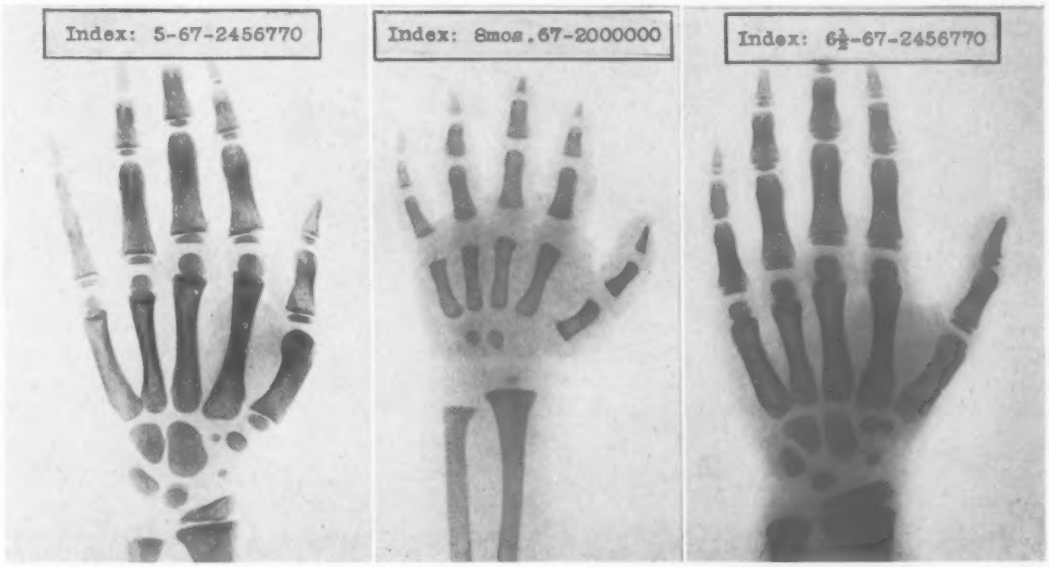

Fig. 3. Further application of the "ossification index" in the interpretation of bone development. All of these examples show centers whose latest possible normal appearance is later than the actual age. In spite of these variations, the index is normal and at the same time completely describes the findings.

normal appearance date of the centers, many cases will be found to have centers whose assigned figures are greater than the actual age. Such a case at the age of four may show an index of 4-67-2456000 indicating that this child might have an ossification age of six. Up to a certain point this is normal when considering only the *first appearance* of the centers. If, on the other hand, some evidence of obliteration of the epiphyseal lines is present in secondary centers, there may be an accelerated condition requiring study. However, in the majority of cases it can be said with certainty that the NORMAL OSSIFICATION INDEX is any group of figures, obtained in this manner, which includes all of the numbers in the make-up of the index, it is felt that a simple anteroposterior flat roentgenogram will give all of the needed information. For uniformity it is also suggested that the left hand be used and the diagrammatic explanation of the index has been planned for these roentgenograms. However, if a view of the right hand has been taken, the negative can be turned over on the viewing box to give a quicker indentification of the centers by direct comparison with the diagram.

A similar index with a slightly different type of interpretation may be prepared from the dates of the earliest normal appearance of the centers. This apparently would have less frequent application.

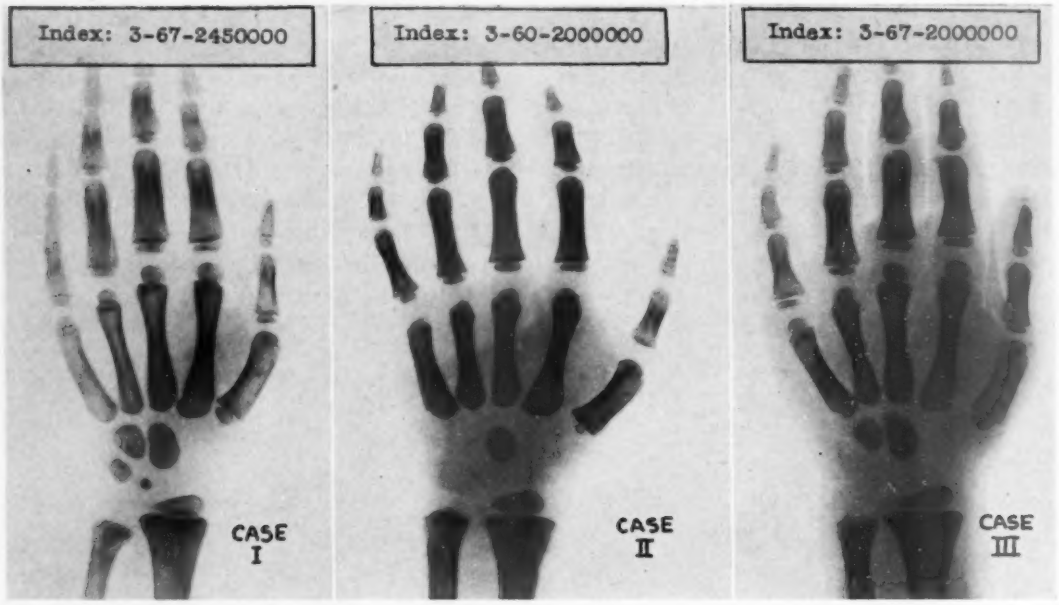

Fig. 4. Roentgenograms showing wide variation in the appearance of centers in 3 cases of the same age. In spite of these wide differences the index shows that Cases I and III are normal. Case II does not show all of the centers up to the actual age and is therefore abnormal. Reference to the "ossification index" immediately shows that the center which should appear before the seventh month has not developed (hamate bone).

SUMMARY

Brief reasons have been presented to justify a claim that a study of the rate of appearance of the ossification centers in the wrist is a workable means of checking upon the presence or absence of chronic metabolic disturbances in childhood. Arbitrary figures have been stated to indicate the earliest and the latest age for the appearance of each center as a means of detecting the extreme variations which are pathological. For the convenient use of these observations it had been suggested that the pediatrician construct an "ossification index" and several examples of the application to actual cases have been demonstrated (Fig. 2, 3 and 4).

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POST-IRRADIATION BONE CHANGES*

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SINCE the advent of high voltage roentgen therapy with increased dosage for certain malignant conditions, various tissue changes have been reported. Pulmonary fibrosis following irradiation of some cases of carcinoma of the breast, rectal and bladder ulceration following irradiation for pelvic malignancies, atrophy and disturbance of growth of soft tissues, and aseptic bone necrosis often followed by fracture have been reported.

EFFECTS OF IRRADIATION ON BONE

Hillstrom,[13] whose untimely death prevented publication of his experimental data, found that on roentgen irradiation of the tibial epiphyses of two-weeks-old rabbits, measurable retardation of growth occurred in the bone when at least 40 per cent of a skin erythema dose was administered. He further observed that the retardation of growth was proportional to the increase in roentgen dosage and that divided doses are less effective than single equal doses. Hillstrom also found that roentgen rays, in certain doses, retard periosteal as well as endochondral bone growth, the latter being reduced from 84 per cent to 97 per cent of normal, by quantities of roentgen rays ranging from 100 per cent to 40 per cent skin erythema dose (1,000 r in air in one application being regarded as one skin erythema dose), the heavier the dose, the slower the growth. The ultimate shape of the bone or the duration of its growth is not noticeably altered by irradiation. Other experimental evidences of similar character have been presented by various authors.[5,8,14,30]

Stevens[31] and Slaughter[29] have reported clinical observations of definite retardation of bone growth occurring after irradiation over the epiphyses of growing bones. We have had a similar experience in at least one instance.

CASE REPORT

H. J., a male child, aged five months, was treated for a rapidly growing hemangio-endothelioma of the anterior aspect of the right thigh. The lesion measured 12.5 by 17 cm. at the time of the first roentgen treatment. A dose of 450 r in air was administered to the lesion at a distance of 50 cm., using a 190 kv. (peak) therapy unit, filtered with 0.5 mm. copper and 1 mm. aluminum.

The same dose was repeated three and eight months following the first treatment, making a total of 1,350 r to the lesion. Nine months following the last treatment the lesion had practically disappeared, leaving an indurated area 8 by 10 cm. over the right mid-thigh.

At the age of nine years the right femur was 3 cm. shorter than the left and 5 cm. smaller in circumference at the middle region of the thigh.

The right leg was 1 cm. shorter than the left and 1.5 cm. smaller in circumference.

One year later there was approximately an equal increase in the length of the femora and the circumference of the thighs; however, the difference between them remained the same. The bones of the legs also increased equally in length. While the circumference of the left leg increased 3.5 cm. in one year, the right increased only 1 cm.

The question arises as to whether this change in growth is entirely due to the irradiation of the distal femoral epiphysis itself or is partly due to the disturbance in the blood supply to the thigh and leg occasioned by the fibrosis resulting from the healing of the malignant lesion. It seems logical to assume that the change was mostly on a circulatory basis, since the bones of the leg are likewise of different lengths. Stevens' case had retardation in growth of the bones of the leg; treatments were also given over the thigh and pelvis, which revealed a similar lack of growth.

It has been well established that irradiation, especially when excessive, produces thickening, fibrosis, and finally obliteration of the blood vessels.[7] Furthermore, dis-

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turbances in circulation produce profound changes in bone structure, often resulting in death of the bone, manifested by so-called aseptic necrosis and bone infarcts. The clinical studies on the late effects of dislocation at the hip joint[24] and on caisson disease of bone[4,15,27] have abundantly borne out the experimental work.

Bone has a high calcium content, which produces a considerable amount of secondary radiation. Ewing[7] has shown histologically that irradiated bone presents widening and irregularity of lacunae and canaliculi with a partial loss of lamellar structure. Considerable time must elapse after irradiation for these changes to appear. It may take six months before a line of separation of the dead bone becomes apparent in the roentgenogram and the other bone changes become clearly visible.

The most commonly reported bone change resulting from irradiation is fracture of the neck of the femur. The anatomy of the femur and its blood supply are important considerations in estimating the factors which contribute to this result. The blood supply to the head and neck of the femur is limited largely to the arteries in the capsular ligament and the ligamentum teres. In a certain percentage of individuals there are no blood vessels in the latter ligament. The sharp limitation of the blood supply to the proximal end of the femur makes it peculiarly susceptible to aseptic necrosis and ununited fracture.

The neck of the femur varies in length and obliquity at different periods of life. In the adult it forms an angle of about 130 degrees with the shaft, but varies in inverse proportion to the development of the pelvis and the stature of the individual. In consequence of the widening of the pelvis in the female, the neck of the femur forms more nearly a right angle with the shaft than it does in males. Furthermore, the thickness of the neck is usually considerably less in females.

INCIDENCE OF IRRADIATION FRACTURES OF THE FEMORAL NECK

Spontaneous fracture of the femoral neck among the general population occurs probably only once or twice in four or five thousand persons in the seventh decade and occurs more commonly in women than in men, at a ratio of three to one.[26] This is probably due to the osteoporosis and resultant weakening which accompany advanced age.

Roentgen injury to the bones of the pelvic girdle was not reported until 1927 when Baensch[1] of Leipzig cited 2 cases of fracture of the neck of the femur following roentgen therapy for carcinoma of the cervix and ovary respectively. Kropp[17] reported a similar case with fracture of the left femoral neck.

In 1932 Philipp[25] reported 5 cases of fracture of the neck of the femur following heavy irradiation to the pelvis through large fields including lateral fields. In none of his cases was there a history of trauma.

Dalby, Jacox and Miller[6] in 1936 added 14 cases of fracture of the femoral neck. In their series no direct radiation was given over the femoral neck nor were lateral fields over the trochanters used. Baker[3] reported a case of spontaneous fracture of the femoral neck following radiation therapy of the pelvis where no lateral fields were utilized.

Peck[23] found that out of 1,026 patients with malignant lesions in the pelvis who were seen in the Gynecological Neoplasm Conference, between July, 1931, and January, 1938, 28 were reported with spontaneous femoral neck fractures, an incidence of 2.7 per cent. He states that no exceptionally high incidence of fracture appears for any particular type of pelvic cancer.

Okrainetz and Biller[21] of the Montefiore Hospital in New York City added 1 case to the series of spontaneous femoral neck fractures. In this instance the roentgenographic changes in the femoral neck, which most likely represented bone necrosis, were thought to be due to metastasis, and further therapy was administered. The patient succumbed to the papillary adenocarcinoma of the ovary two years after occurrence of fracture of the right femoral neck. The complete pathologic description of this

femoral neck is given. The report states that there was "no evidence of metastasis," and "marked thickening of the walls of many blood vessels, some of which showed hyaline intimal necrosis, others complete obliteration." Furthermore, "new bone formation could not be seen."

Hight[12] reported the only case of fracture of the femoral neck in a male. His patient was fifty-nine years of age, and deep roentgen therapy was administered through portals in each groin for carcinoma of the penis; 1,600 r was given to each field. Four months after therapy, pain in the left hip developed, and a fracture was demonstrated roentgenographically.

Strauss and McGoldrick[32] reviewed the literature up to June, 1941, and were able to collect 55 cases of spontaneous fracture of the femoral neck following irradiation. They suggest that lateral fields are largely responsible for the accident.

Irradiation necrosis and fracture of other bones have been reported on many occasions. Among others, Kanthak[16] has observed "osteoradionecrosis" of the jaws. He states that "three definite factors seem to be conducive to this change, irradiation, infection, and trauma."

Slaughter[29] in 1942, reported on 8 cases of necrosis and fracture of the clavicle and ribs following irradiation for carcinoma of the breast. He estimated that the range of tissue doses delivered to the clavicle or ribs was 1,500 to 4,000 r, averaging approximately 2,000 r. Paul and Pohle[22] found that doses of 5,200 to 6,000 r per field were given in 10 patients who developed rib fractures following irradiation for carcinoma of the breast.

It is notable that irradiation fractures or osteitis of the pelvic bones, such as the pubic ramus, the sacrum, or the ilium, have not been reported, although the pubic bone particularly receives much larger amounts of radiation than does the femoral neck. The cases herein reported are unusual in that they include 3 cases (VI, VII and VIII) of multiple fractures and osteitis of the bones of the pelvis.

Since November, 1940, at the University of Minnesota Hospitals routine roentgenograms of the pelves of all individuals referred for deep roentgen therapy of malignant conditions of the pelvis have been made before treatment and at yearly intervals thereafter. Furthermore, all patients treated since 1936 have been recalled and have been roentgenologically examined for evidences of injury of the pelvic bone. If symptoms develop, earlier studies are made. Thus far, no fractures or necroses have been demonstrated in patients entirely without symptoms, while several cases developed symptoms well before the appearance of roentgenographic evidence of necrosis or fracture. Subsequent roentgenograms demonstrated definite bone changes a month or two after the first complaint. We have had no postmortem studies to permit reports on the bone pathology.

Since the institution of high voltage roentgen therapy in July, 1926, to December, 1942, 1,904 patients have been treated for malignant conditions of the pelvis. This series includes:

	Cases
Carcinoma of the cervix	960
Carcinoma of the corpus uteri	195
Carcinoma of the ovary	208
Carcinoma of the prostate	376
Carcinoma of the bladder	165

There were 31 additional cases but these have been excluded, as they received treatment within the period from July 1, 1942, to December, 1942, and therefore a long enough interval had not elapsed for the usual roentgenographic changes to take place in the femoral head or neck. While most of the evidence indicates that six to eight months must elapse after irradiation before evidences of bone necrosis appear, we have seen 2 cases (I and III) in which definite roentgenographic changes appeared within five months.

Since the institution of our search for patients with bone changes incident to irradiation, 25 instances of bone necrosis or spontaneous fracture in 19 patients have been encountered. These represent 13 frac-

tures of the femoral neck in 11 patients (2 being bilateral), 2 cases of multiple fractures of the pelvis in 1 of which a fracture of the femoral neck developed later, 8 cases of definite sclerosis or areas of necrosis in the head or neck of the femur (1 being bilateral), and 1 case of sclerosis of the right ilium with fracture of the pubic rami.

During the period 1936–1941, 568 female patients were treated with irradiation for malignancies of the internal genitalia. Within this period were observed all but one of the cases detailed above. In this series, therefore, there were 18 patients with serious bone sequelae, or an incidence of 3.2 per cent. Two additional patients sustained fractures, but these followed serious injury, and preceding changes in the neck of the femur were not observed.

The statement of incidence is obviously not complete, inasmuch as it can be expected that more of the patients in this group will develop abnormal changes in the femur. This is demonstrtaed by 1 of our patients (Case v) who developed signs of necrosis almost six years after completion of the radiation therapy. It therefore might be more accurate to state that we can expect at least 3.2 per cent of females with pelvic cancer, who are subjected to radiation therapy, to subsequently develop disability from degenerative changes in the femur.

In 541 male patients treated for carcinoma of the bladder or prostate no fractures nor any other bone sequelae, which could be assigned to the irradiation, were encountered. We have seen 1 instance of fracture of the neck of the femur in a patient who had been treated with roentgen rays for carcinoma of the prostate, but the fracture followed a moderately severe injury and appeared to be purely on a traumatic basis.

It is notable that among the numerous reported cases of carcinoma of the prostate and bladder in males that were treated by heavy pelvic irradiation, there have been no instances of bone injury. The differences in the anatomy between males and females, the same factors which produce traumatic fractures three times more often in females than in males, possibly the more restricted fields of radiation often used in the treatment of carcinoma of the prostate, and the shorter life span of the latter patients after irradiation may all be operative in effecting this striking sex difference.

PROBABLE FACTORS CONTRIBUTING TO BONE CHANGES

No satisfactory explanation can be given as to why one patient develops aseptic necrosis or a spontaneous fracture after deep roentgen irradiation while another who has received a similar dosage reveals no bone changes. It is also difficult to explain why necrosis and fracture occur in one femur only, although an identical dosage of roentgen rays was administered to both sides of the same pelvis.

The advanced age of some of our patients may be a contributing factor to many of the bone changes. However, one of the fractures developed in a patient who was only thirty-four years of age (Case vi). About half of the irradiation effects in our series occurred in patients between the ages of forty and sixty, which compares favorably with the age incidence of pelvic malignancy.

It is difficult to assess the importance of mild dietary deficiencies in the subsequent development of bone changes. Spontaneous fractures of bone do occur in patients whose diet is deficient in vital elements, especially calcium. In none of our cases did there appear to be a definite dietary deficiency.

The quantity of radiation applied is undoubtedly an important matter. That this is not the only factor is evident from an analysis of our cases. Five patients who were treated prior to 1938, when the total radiation dose was lower, developed pathologic changes in the femoral neck. However, in most of these patients two courses of deep roentgen therapy were given, even though there was no evidence of a residual malignant lesion. One patient developed bone changes after what is now considered to be a relatively small total tumor dose—

TABLE I

SUMMARY OF CASES DEVELOPING POST-IRRADIATION BONE CHANGES

Case	Year of Treatment	Site of Cancer and Stage	Age	Weight	Calculated Tissue r Dose to Tumor	Interval to Fracture or Necrosis	Comment on Fracture or Necrosis
I M.B.	1940	Vagina	74	107	3,140 (over 31 days)	5 mo.	Fracture neck left femur with marked displacement. No treatment. Fracture united later. (See case report)
II L.A.	1938	Cervix III	58	162	2,760 (over 30 days)	30 mo. and 35 mo.	Bilateral fractures healed with McMurray osteotomies. (See case report)
III L.B.	1941	Cervix I	65	124	2,780 (over 21 days)	5 mo.	Roentgen evidence of sclerosis neck right femur. No disability. (See case report)
IV R.H.	1940	Cervix I	72	157	2,870 (over 34 days)	12 mo.	Roentgen evidence aseptic necrosis neck right femur. Some pain but able to be up and bear weight. (See case report)
V A.K.	1936	Cervix II	61	130	2,180 (1936) (24 days) left	21 mo.	Left—minor complaint pain on walking. Necrosis of head. Increasing difficulty
					2,180 (1937) (24 days) right	62 mo.	Right—same findings as left appearing three years later. (See case report)
VI M.H.	1936	Cervix I	34	101	1,800* (over 26 days)	7 mo.	Fractures and necrosis of pelvic bones after injury
					1,800* (over 26 days)	24 mo.	Fracture neck femur without recent injury. (See case report)
VII T.L.	1941	Cervix II	55	83	2,810 (over 23 days)	9 mo.	Multiple fractures 5th lumbar vertebra, sacrum, symphysis pubis without injury. (See case report)
VIII T.T.	1939	Cervix III	51	115	2,500 (over 25 days)	32 mo.	Sclerosis right ilium near sacroiliac joint and fractures of pubic rami without injury. (See case report)
IX M.B.	1935	Cervix III	58	130	1,540 (over 20 days)	65 mo.	Fracture neck right femur. McMurray osteotomy right femur
X H.B.	1936	Cervix III	48	140	1,860* (over 30 days)	48 mo.	Fracture left femoral neck and bebinning sclerosis on right. McMurray osteotomy on left side
					1,860* (over 30 days)		
XI I.D.	1940	Cervix III	62	140	2,800 (over 27 days)	8 mo.	Fracture neck right femur. Treatment refused. Died 4 months later presumably of recurrent tumor
XII S.H.	1940	Cervix III	57	100	3,000 (over 24 days)	11 mo. and 13 mo.	Fracture neck right femur treated with body spica. Left femur showed osteoporosis and possible fracture. Treatment, bone graft
XIII L.B.	1940	Cervix II	48	100	2,940 (over 26 days)	15 mo.	Fracture neck right femur. Treated with bone graft
XIV B. McM.	1937	Cervix III	57	124	2,080* 2,080* (over 30 and 24 days)	16 mo.	Slight fracture neck right femur. Some pain but not incapacitating
XV I.B.	1938	Cervix II	64	125	2,480 (over 28 days)	12 mo.	Aseptic necrosis head left femur. Incapacitated by pain in left hip. McMurray osteotomy left femur

Table I (*Continued*)

Case	Year of Treatment	Site of Cancer and Stage	Age	Weight	Calculated Tissue r Dose to Tumor	Interval to Fracture or Necrosis	Comment on Fracture or Necrosis
XVII M.S.	1940	Cervix II	48	160	2,420 (over 30 days)	7 mo.	Sclerosis and necrosis neck right femur. Patient died of recurrent carcinoma
XVI H.D.	1937	Corpus II	68	196	2,440** (over 29 days) 2,340** (over 13 days)	9 mo.	Fracture neck left femur. Treated with bone graft
XVIII J.S.	1939	Cervix I	48	125	2,540 (over 25 days)	36 mo.	Fracture neck right femur. Marginal sclerosis left femoral neck. No special treatment to December, 1942
XIX L.N.	1940	Corpus	66	160	2,850 (over 23 days)	24 mo.	Fracture neck left femur. Treated with bone graft

* Second course of roentgen therapy given approximately one year after initial treatment.
** Second course of roentgen therapy given three years and nine months after initial treatment.

1,540 tissue roentgens (Case IX). Nevertheless, the incidence of bone changes increased appreciably after the institution of more intensive therapy.

Since 1938 the treatment of pelvic malignancies in women has been well standardized in our clinic. In carcinoma of the cervix and corpus a total calculated depth dose is given, amounting to 2,700 to 3,000 tissue roentgens to the region of the lesion. A 220 kv. (peak) deep therapy unit is utilized with 15 ma. intensity, filtered with 1 mm. of copper and 1.2 mm. of aluminum (half-value layer 1.75 mm. of copper). The focal skin distance is 60 cm. on the lateral and oblique fields and 70 cm. for the anteroposterior fields. Six or eight pelvic fields are utilized, depending upon the size of the pelvis. A course of treatments is given over a period of twenty-four to thirty days.

Radium emanation follows immediately after completion of roentgen therapy to the pelvis. Usually five fields are utilized for the radium applications two of which are in the uterus and three in the vagina, delivering a total of 5,000 mg-hr. in a period of one hundred hours. Where the uterus or vagina will not permit the use of five fields, the total dose is decreased to 4,000 or 4,500 mg-hr., but the application is kept constant at one hundred hours.

Most authors agree that the radium application probably plays a very minor rôle in the development of post-irradiation bone changes because of the distance of the radium from the femora. However, the possible effect of the emanation on the pelvic arteries, causing a decrease or complete obliteration of the blood supply, must be considered as an accessory factor.

CLINICAL FINDINGS

The usual complaint of most patients is a mild aching pain in the affected bone, which may radiate to the anterior thigh. The pain at first is not incapacitating and in some cases may never cause total disability. However, in our series most of the patients have eventually become somewhat incapacitated, and some have required orthopedic interference.

In such cases as developed a complete fracture and necrosis of the femoral neck there was revealed the usual shortening of the femur, the coxa vara deformity at the hip, and the external rotation of the lower extremity.

TREATMENT

The method of treatment of spontaneous fractures of the femoral neck has depended upon the extent of the pathologic condition.

Where a clear fracture and necrosis were demonstrated on the roentgenograms, a McMurray osteotomy of the femur was performed. In 1 instance with the fracture in good position, a tibial bone graft was introduced into the neck of the femur. A similar graft was inserted in another case where it appeared that a fracture was imminent; however, this was done after the patient had developed a definite fracture in the opposite femoral neck. No specific treatment has been devised for patients with bone necrosis. Because of the usual pain, the activities of most of these individuals are curtailed involuntarily.

Table 1 summarizes the entire group of patients with post-irradiation bone changes in the femur or pelvis.

A study of these cases reveals a number of salient findings. While symptoms usually appeared prior to clearly demonstrable roentgen findings, it was possible, especially when roentgenograms had been obtained at the time of treatment, to predict impending fracture by the sclerotic changes in the femoral neck (Fig. 2*a* and 3*a*). Careful study of the trabeculae in most instances will reveal areas of increased density. Especially significant is a transverse line of density running across the femoral neck, occasionally accompanied by small areas of rarefaction (Fig. 7*a*). Likewise the changes in the head of the femur may be detected in their earliest stages if repeated routine examinations are made (Fig. 4 and 5). The head becomes slightly denser than normal, the detail of the trabeculae is lost, and then areas of rarefaction appear. Similar changes are found in the acetabulum neighboring the joint (Fig. 4*b* and 5*b*). In 1 instance (Fig. 3*b*) a complete defect in the head of the femur was the first observation. The resemblance to the progressive changes of osteochrondrosis of the femoral head (Perthes' disease), to those found in post-traumatic aseptic necrosis and in caisson disease is striking. It tends to bear out the theory that all have a common origin in vascular changes.

Within this group of cases there were 3 of unusual interest which are reported in detail below. In all of these (Fig. 7, 8 and 9) multiple fractures of the pelvis were found involving the sacrum, and the pubic rami. These fractures occurred in 1 case with some trauma, in the other 2 without apparent trauma. They were unusual in their appearance and produced minimal symptoms, considering the extent of the bone injury. In 2 of these the possibility of osteoclastic metastases to the pelvis was considered, but the true diagnosis was established by the course of events.

CASE REPORTS

The following cases are reported in greater detail, as they illustrate the findings obtained:

CASE I. M. B., aged seventy-four was admitted in May, 1940, with a diagnosis of squamous cell carcinoma of the vagina. A series of high voltage roentgen treatments was administered, yielding a calculated tumor dose of 3,140 r. Radon seeds were implanted at the periphery of the lesion, 1,128 millicurie-hours being the total dose.

In November, 1940, five months after therapy, the patient noticed pain in her left hip and thigh. There was no history of injury. The first roentgenogram made in December, 1940, revealed a fracture of the left femoral neck with marked malposition. No specific therapy was given, and in October, 1941, the patient was walking without difficulty; roentgenograms revealed good healing at the fracture site.

Comment. This patient presents the typical findings in a case of irradiation fracture. The appearance of pain without antecedent injury, the consequent occurrence of disability, and finally the roentgen demonstration of a fracture are characteristic. Roentgenograms had not been made prior to the occurrence of the fracture. Note the appearance of symptoms within five months after irradiation and the demonstration of the fracture one month later.

CASE II. L. A., aged fifty-eight, in November, 1938, was found to have a squamous cell carcinoma of the cervix uteri. The dose given was 2,760 tissue roentgens to the tumor by high

Fig. 1. Case II. Right hip. *a*, normal right femur, fourteen months after irradiation. The left femur also appeared normal at this time. *b*, fracture of neck of right femur with zone of sclerosis, thirty-three months after irradiation. Note the characteristic zone of sclerosis of neck of femur (arrow) and the moderate displacement.

voltage roentgen rays, followed by 5,000 mg-hr. of radium emanation applied directly. Roentgen examination February 15, 1940, indicated both hips to be normal. In Figure 1*a* is illustrated the roentgenogram of the right hip at that time. The left was similar.

In April, 1941, two and half years after the therapy, the patient noticed pain in her right hip without preceding injury. Examination July 23, 1941, demonstrated a fracture of the right femoral neck (Fig. 1*b*) and sclerosis with a partial fracture of the left femoral neck (Fig.

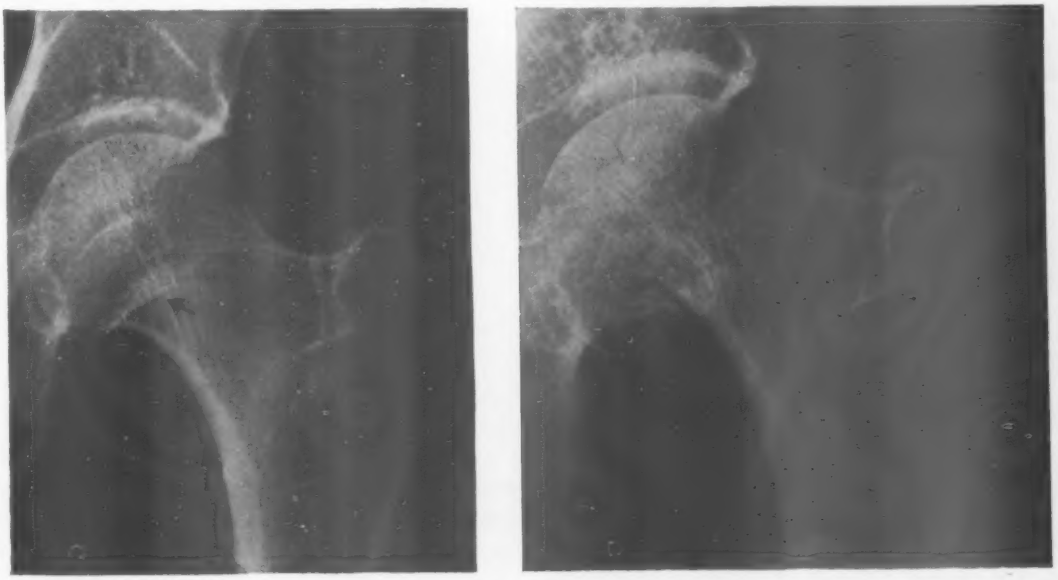

Fig. 2. Case II. Left hip. *a*, zone of sclerosis and beginning fracture line (arrow) visible thirty-three months after radiation therapy. *b*, complete fracture of neck of left femur three months after roentgenogram shown in *a*.

FIG. 3. Cases III and IV. *a*, Case III. Sclerosis of neck of femur appearing five months after last irradiation. Note the zone of rarefaction just distal (lower arrow) to the zone of sclerosis (upper arrow). The hip was cared for at once, and a complete fracture did not develop. *b*, Case IV. Aseptic necrosis of femoral head appearing twelve months after irradiation. Note the complete defect in the head (arrow) and some sclerosis bordering it.

2*a*). In August, 1941, a McMurray osteotomy was performed on the right side. On October 9, 1941, while turning in bed, she sustained a complete fracture of the left femoral neck (Fig. 2*b*) and a McMurray osteotomy was performed on that side. In December, 1942, the patient was able to be around the hospital ward with a mechanical aid.

Comment. This is a typical example of a bilateral irradiation injury. The opportunity for examination of the left hip before a fracture occurred was afforded here. The symptoms referable to the left hip were minimal, but the roentgen evidences of impending fracture as shown by the sclerosis and rarefaction were perfectly clear. The difference in the time of appearance of the bone changes on the two sides is notable.

CASE III. L. B., aged sixty-five, was found to have a squamous cell carcinoma of the uterine cervix in March, 1941. Roentgen therapy was administered, with a tumor dose of 2,780 r, followed by 4,500 mg-hr. of radium emanation applied directly to the cervix.

A roentgenogram of the pelvis was made at the beginning of treatment, March 4, 1941, and the femora appeared normal. In July, four months after the last treatment, she developed pain in the right hip and difficulty in walking. There was no history of injury. Roentgen examination one month later (Fig. 3*a*) revealed a zone of sclerosis and an area of rarefaction in the femoral neck. Restriction of motion was enjoined upon her, but no other therapy was administered. On March 11, 1942, another roentgen examination showed an increase in the process. Her symptoms had diminished, and a complete fracture did not develop. The pain later disappeared completely.

Comment. The rapidity of development of symptoms (four months) and roentgen signs (five months) is notable. The characteristic zone of sclerosis and necrosis was clearly made out. It is remarkable that it did not progress further. In many instances such a zone of sclerosis can be observed prior to the actual occurrence of a fracture. It may be possible that a slight trauma will precipitate the completion of the process.

CASE IV. R. H., aged seventy-two, in March, 1940, was found to have a squamous cell carcinoma of the cervical stump. A series of deep

roentgen treatments was administered, with a tumor dose of 2,870 r. This was followed by 4,000 mg-hr. of radium emanation.

In May, 1941, one year after the therapy, the patient complained of pain in her right hip and thigh without preceding injury. A roentgenogram (Fig. 3*b*) revealed aseptic necrosis of the right femoral head. There was a defect on the articular surface but little or no sclerosis. Subsequent examinations revealed no further progress of the necrosis, and the patient had less pain.

Comment. The defect in the femoral head is striking. No sclerosis was seen, probably because roentgen examination was not made earlier. It is remarkable that so much change had occurred so quickly after the onset of symptoms. The appearance indicates that in this case roentgen findings might have been detected prior to the first symptom.

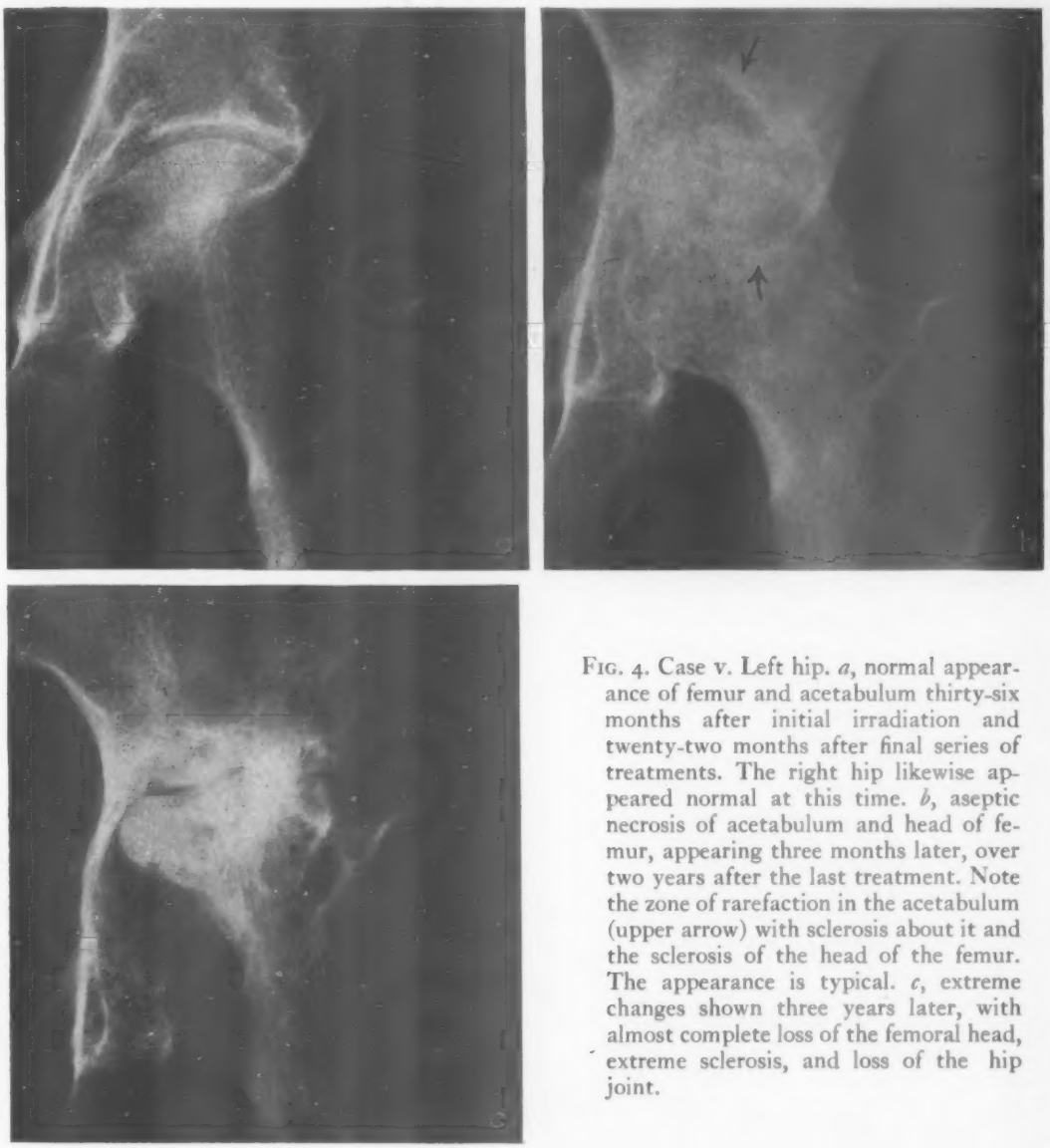

FIG. 4. Case v. Left hip. *a*, normal appearance of femur and acetabulum thirty-six months after initial irradiation and twenty-two months after final series of treatments. The right hip likewise appeared normal at this time. *b*, aseptic necrosis of acetabulum and head of femur, appearing three months later, over two years after the last treatment. Note the zone of rarefaction in the acetabulum (upper arrow) with sclerosis about it and the sclerosis of the head of the femur. The appearance is typical. *c*, extreme changes shown three years later, with almost complete loss of the femoral head, extreme sclerosis, and loss of the hip joint.

CASE v. A. K., aged sixty-one, was admitted in November, 1936, when a squamous cell car-

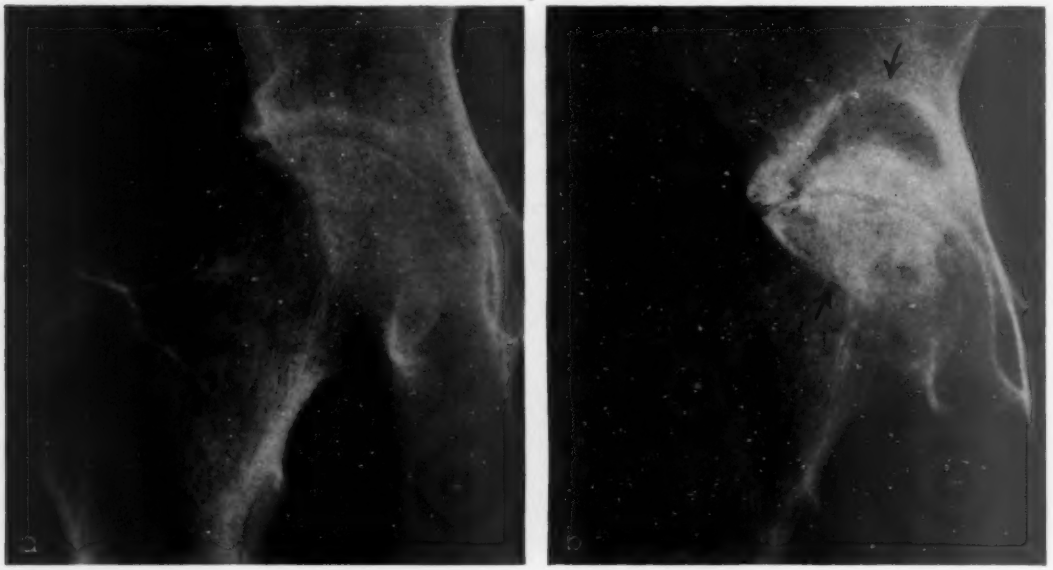

FIG. 5. Case v. Right hip. *a*, considerable changes in head of right femur, appearing for the first time five years and two months after the last series of roentgen treatments and well over three years after the onset of findings in the left hip. *b*, characteristic sclerotic and necrotic changes shown in the acetabulum (upper arrow) and in the head of the femur (lower arrow) ten months later. The appearance is characteristic of aseptic necrosis.

cinoma of the cervix uteri was found. An initial treatment consisting of 2,100 mg-hr. of radium emanation was applied directly, and in December, 1936, 2,400 mg-hr. of radium emanation was added. This was followed by high voltage roentgen therapy with a calculated tumor dose of 2,180 r. A similar series of roentgen treatments was administered in March, 1938.

In January, 1940, three years after the initial treatment and one year and ten months after the final series, the patient complained of pain in the left hip. There was no history of injury. Roentgenographic studies revealed no evidence of bone change in either hip. The roentgenogram of the right hip only is here illustrated (Fig. 4*a*). Re-examination April 6, 1941 (Fig. 4*b*) disclosed sclerosis of the head of the left femur and rarefactions in the acetabulum, which increased in severity within the next five months and eventuated in a high degree of loss of the femoral head and of the joint (Fig. 4*c*).

The patient continued her usual activities (insurance saleslady) with discomfort but without great disability. She refused hospitalization and treatment. On May 19, 1943, she returned for re-examination, now complaining of pain in the right hip. The findings on the left had remained much the same, but the head of the right femur showed minimal changes (Fig. 5*a*). Re-examination three months later showed a definite aseptic necrosis of both the head of the right femur and the acetabulum. The final examination was made February 9, 1944 (Fig. 4*c* and 5*b*), both hips showing similar changes, the left more severe than the right.

Comment. One may well ask why the right hip developed necrosis almost two years after the left and over five years after the last treatment, although there were no intervening incidents that were apparent. The curious factors underlying the development of irradiation necrosis are obviously not entirely clear. The characteristic early changes and the progression of a case of aseptic necrosis of the hip are well illustrated in this case.

CASE VI. M. H., aged thirty-four, was found to have a squamous cell carcinoma of the cervix uteri on examination in December, 1935. She received 1,800 tissue roentgens to the tumor, and this was followed by 3,600 mg-hr. of radium emanation directly applied.

In October, 1936, roentgenograms of her pelvis (Fig. 6) showed numerous lesions which were mistaken for metastases, and a second series of roentgen treatments was administered. There

were no changes present in the femora to indicate metastasis or fracture. Subsequent history revealed that this patient had been in an automobile accident in July, 1936, with moderate injuries, which were treated elsewhere. Roentgenograms made at that time showed the fractures, but their appearance was most unusual and they united very slowly. The disability suffered was relatively small. Large defects appeared shortly in the fracture areas. It was these which led to the erroneous diagnosis of metastases. Re-examination February 10, 1937, showed the femora to be normal and the defects in the pelvis to be slowly filling in.

In September, 1938, three years following the first irradiation and almost two years after the second series, the patient noticed pain in her right hip on weight bearing, and roentgenographic studies (Fig. 7*a*) revealed some sclerosis and a defect in the neck of the right femur. Subsequent studies (Fig. 7*b*) demonstrated some displacement and eventual repair of the fracture without any special treatment. She was last seen in November, 1941, without any evidence of recurrence of tumor and a well healed fractured femoral neck. The fractures of the pelvis had also united.

Comment. This case presents certain striking findings. Despite the definite injury in July the character of the bone changes in the pelvis suggests an irradiation effect. De-

Fig. 6. Case VI. Multiple fractures of the pelvis following irradiation. Multiple areas of defect and fracture in the sacrum (upper arrow), rami of both pubic bones (lower arrows), and a large defect in the body of the right pubic bone (arrow) were found nine months after the irradiation. The patient had suffered an injury three months earlier.

spite the fractures of the pubic rami and the sacrum, the femoral necks were not injured. She was only thirty-four years old and suffered relatively little from the changes in her pelvis. The unfortunate error in which the rather unusual appearance of the fractures of the pelvis were mistaken for metastases resulted in a second series of treatment. Apparently the effect of the addi-

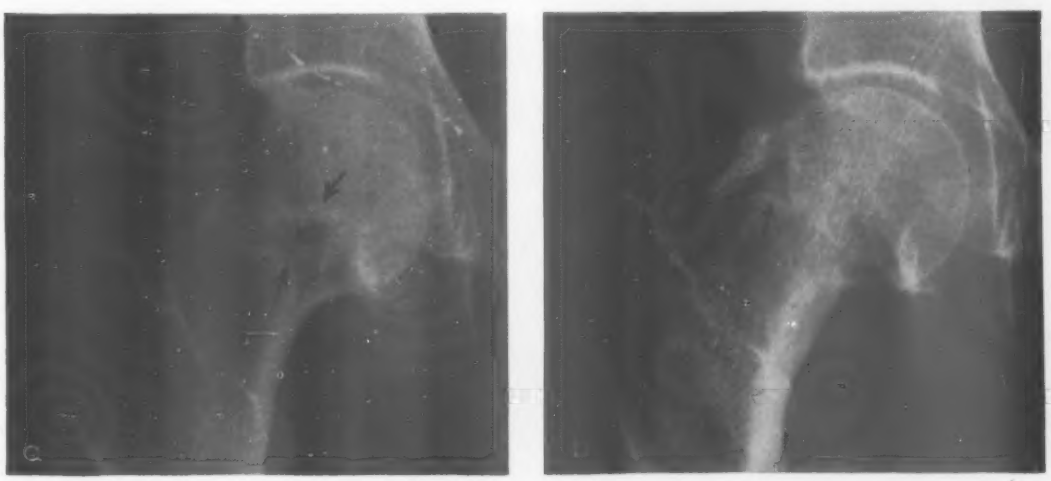

Fig. 7. Case VI. Right hip in same case as Figure 6. *a*, necrotic area in neck of right femur with sclerosis (arrows) appearing about three years after the first irradiation and two years after a second series which was given following the discovery of the lesions in the pelvis. Pain was present at this time. *b*, twenty-four months later some areas of necrosis (arrow) are still present. The fracture has become complete, and there has been some displacement, but union has taken place.

FIG. 8. Case VII. Multiple fractures and necrosis of the pelvic bones following irradiation. Note the marked disorganization of the pubic rami, large areas of defect, fractures of the transverse processes of the fifth lumbar vertebra and of the sacrum with some sclerosis about them (multiple arrows). These findings appeared approximately nine months after irradiation without preceding trauma. There has been a gradual but definite repair.

tional irradiation was sufficient to produce a spontaneous fracture of the femoral neck. It would appear that even trauma will not necessarily produce a fracture of the femoral neck if the conditions following irradiation are not conducive to it.

CASE VII. T. L., aged fifty-five, was found to have a squamous cell carcinoma of the cervix uteri in April, 1941. She was treated with high voltage roentgen rays, yielding a calculated tumor dose of 2,180 r over a period of twenty-three days. Radium emanation of 3,500 mg-hr. was given by direct application two weeks later.

In February, 1942, eight months after completion of the radiation therapy, the patient complained of pain in her pelvis. There had been no injury. Roentgenograms revealed multiple, rather destructive fractures of the pubic rami, the sacrum, and the transverse processes of the fifth lumbar vertebra. The amount of pain and disability was astonishingly small considering the extent of the process. In August, 1942, re-examination (Fig. 8) revealed much the same findings except that there was some tendency toward repair and some increased displacement of the fragments. By December the patient was fully ambulatory but still had some pain. Two years later she was apparently well and had no complaints.

Comment. The close resemblance to Case VI is striking. In this patient there was no injury. As in Case VI the fractures were atypical, and the displacement of some of the fragments was rather marked. There is increased density of the sacrum suggesting some sclerosis here as well. While the whole appearance is unusual, the absence of injury, the relatively minor symptoms, and the appearance of the changes eight months after irradiation all indicate clearly that these bone lesions were due to the radiation therapy.

CASE VIII. T. T., aged fifty-one, presented herself September 19, 1939, and was found to have an adenocarcinoma of the cervix in Stage III. She was treated with roentgen rays in November, 2,500 r being applied to the tumor over a twenty-five day period. This was followed by direct application of 5,000 mg-hr. of radium emanation. In November, 1940, a nodule was found in the vagina and this was again treated by direct application of radium. In March, 1941, she complained of "rheumatism" in her right leg, but this was transient

FIG. 9. Case VIII. Fractures and aseptic necrosis of pelvic bones following irradiation. Note fractures of rami of right pubic bone and area of necrosis of left pubic bone. Note areas of sclerosis about the right sacroiliac joint and also to a lesser degree around the left. These findings all appeared without apparent trauma thirty-two months after irradiation.

and disappeared within a month. There was no history of injury other than an accident eight years before which resulted only in some facial bruises. In June, 1942, a routine roentgenogram (Fig. 9) of the pelvis was made and revealed healing fractures of the rami of the right pubic bone, rarefaction of the body of the left pubis, and sclerosis of the right ilium alongside the sacroiliac joint. There were no complaints at this time. Six months later, in December, 1942, she slipped on the ice and sat down hard. Following this she had pain in her back but there was no disability. In April, 1944, she complained of pain about both sacroiliac joints, more especially the left. Roentgen examination at this time showed the fractures to be completely united, the sclerosis about the right sacroiliac joint to be increased, and some sclerosis about the left sacroiliac joint.

Comment. The character of the fractures of the pubic rami occurring without preceding injury and the relative absence of symptoms are characteristic of irradiation effects. The sclerosis about the sacroiliac joints differs sharply in its appearance from benign osteitis and is best explained on the basis of an irradiation effect.

DISCUSSION

It is evident from the cases here presented that irradiation may affect all the bones of the pelvis as well as the neck of the femur. Furthermore, the effects may be multiform, including fractures, sclerosis, osteoporosis, and aseptic necrosis of the femoral head. The symptoms produced were variable but in general were less severe than would be expected from the roentgen appearance. In general, the prognosis of such injuries is fairly good, remarkably good recoveries occurring in many instances with relatively little disability.

SUMMARY AND CONCLUSIONS

1. A case of retardation of bone growth resulting from irradiation of the soft tissues during infancy is reported.

2. In a series of 1,363 patients irradiated for malignant conditions of the genitalia, 25 instances of bone changes in the pelvis or femora, occurring in 19 patients were encountered. In a series of 568 cases in which routine roentgen examinations of the pelvis were made, 3.2 per cent of the cases developed bone sequelae.

3. In 541 male patients treated for carcinoma of the bladder or prostate no bone sequelae were encountered.

4. Particular attention is directed to the occurrence of aseptic necrosis of the head and neck of the femur and the acetabulum, which occurred in eight instances.

5. There were fourteen cases of fracture of the femoral neck in this series.

6. Three unusual cases with multiple fractures and sclerosis of the bones of the pelvic girdle are reported in detail.

7. The bone changes seemed to occur more frequently after the introduction of a more intensive type of radiation therapy. Bone changes, however, occurred after moderate doses as well.

8. Roentgenologically demonstrable lesions in the bones appeared as early as five months and as late as sixty-two months following the radiation treatments. In almost all instances some symptoms were apparent before the roentgen findings became visible.

9. Repeated roentgen examination permitted the demonstration of sclerotic and necrotic changes prior to the development of fracture or frank aseptic necrosis.

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Vol. 53, No. 1

VOLUME DOSAGE IN RADIATION THERAPY*

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IT IS generally agreed that the biological effect produced by a beam of radiation depends on the quantity of energy absorbed from the beam by the tissue traversed. Attempts to measure this quantity directly by microcalorimeters were made but proved impractical. The introduction of the ionization method of measuring the intensity of a beam of radiation placed dosimetry on a sound basis and made possible a practical international unit—the roentgen. It remained for Gray,[6,7] Mayneord[13] and Happey[11] to indicate how these ionization measurements may also be utilized to estimate the energy absorbed in tissues, i.e. the volume or integral dose.

The concept of volume dosage will probably contribute considerably to many problems of dosimetry. It has been used by Mayneord[14] as a logical basis for the selection of the optimum quality for roentgen radiation and by Gray and Read[8] for the measurement of the neutron doses in biological experiments. Present methods of calculating volume dosage, [12,13] while still inexact, are sufficiently accurate to warrant general clinical use.[4] In total body irradiation, in problems of protection and whenever deep-seated lesions are treated, it is important to make these calculations in order to anticipate the severity of the constitutional reaction. In the choice of fields for irradiation of deep lesions, the volume dose may play a decisive rôle.[20,21] Mayneord[13] points out that biological effects which depend primarily on total energy absorption may be expected to show a marked wave length dependence since short wave lengths would be much more effective per roentgen on the surface. For purposes of protection, a tolerance volume dose should also be specified and, as Braestrup[1] indicates, the volume dose does not decrease with distance in the same way as the surface dose. (For example, doubling the target-skin distance may cut the surface dose to one-fourth but the area covered by the beam may be quadrupled.)

The most convenient unit in which to express volume dosage is the "cc.-roentgen."[3,10] This may be defined as the amount of energy absorbed when a dose of one roentgen is delivered throughout one cubic centimeter of water or of "soft" tissue. The cc.-roentgen is not exactly the same as the gram-roentgen defined by Mayneord[13] as the "energy conversion when a dose of one roentgen is delivered to one gram of air." Soft tissue and air are, however, so similar in this respect (energy absorption per unit mass) that the difference between these two units may be neglected for practical purposes. The cc.-roentgen may be converted[12] into ergs by multiplying by 109 (or into calories by multiplying by 2.6×10^{-6}) for roentgen-ray beams. The factor of conversion is, however, not exactly known. This is not important, however, because the procedure of converting cc.-roentgens into ergs actually does not contribute any further information and is superfluous.[13]

The method of calculating volume dosage described by Happey[12] is relatively simple and has been utilized clinically by Ellis.[4,5] This method involves graphical integration of the depth dose curves for a given quality. The results of this integration for a half-value layer of 1.5 mm. Cu are included in the paper by Ellis.[4]

The method outlined by Happey was used to calculate the volume dose in cc.-roentgens per square centimeter of any given field per roentgen measured in air. This quantity—the number of cc.-roentgens per sq. cm. per r measured in air—may be arbitrarily designated as F. The total volume dose is obtained by finding F for a

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given half-value layer and a given thickness of tissue and then multiplying F by the area of the field and the dose in r_{air}, or

Volume dose in cc.-roentgens = $F \times$ area of field $\times r_{air}$

(This method of expression differs from that of Happey[11,12] and Ellis[4] in that the maximum back-scatter figure is included in F. Also, the skin dose is replaced by the air dose, thereby eliminating the back-scatter figure for the given field.) The curves of Figure 1 give the values of F for a half-value layer of 0.9 mm. Cu and a half-value layer of 1.8 mm. Cu. The depth dose and back-scatter figures were kindly furnished by Braestrup[1] and were determined in a full thickness water phantom.

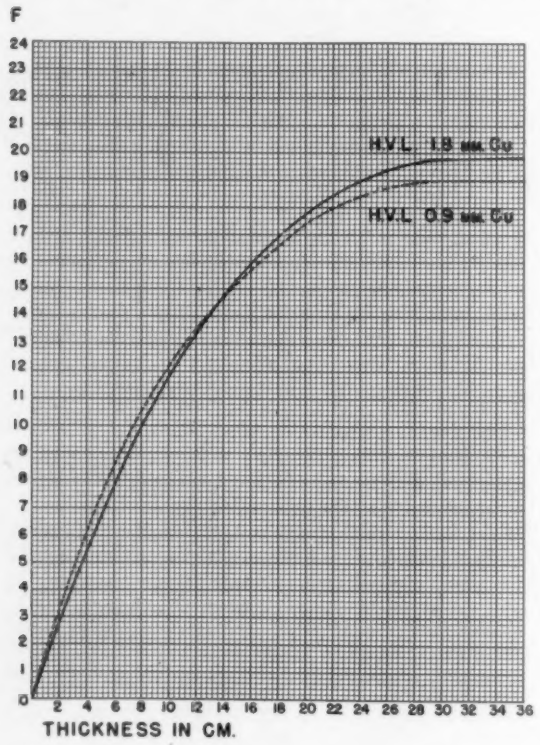

FIG. 1. Graph giving the values of F for different thicknesses for half-value layer of 0.9 mm. Cu and half-value layer of 1.8 mm. Cu. The volume dosage in cc.-roentgens is obtained by multiplying F by the area of the field and the dose, in roentgens measured in air, delivered to the field.

The value of F (in this approximate method) is the same for all target-skin distances for which depth doses may be calculated by the inverse square law from the values for a 50 cm. target-skin distance. According to Quimby[16] and Braestrup,[1] this covers at least the range from 50 to 100 cm. (Ellis[4] shows slightly different values for different target-skin distances presumably because he utilized the depth dose figures published by Mayneord which do not quite follow the inverse square law.)

From the curves it is clear that the differences in volume dosage with beams of these two half-value layers are not great. As expected, for small thicknesses, the energy absorption is greater for the lower half-value layer, while for large thicknesses, the reverse is true.

Example: 300 r measured in air was delivered to a 15×15 cm. pelvic field; half-value layer, 1.8 mm. Cu. The thickness of tissue irradiated was 20 cm. Find the volume dosage.

From the graph of Figure 1, we find that for a half-value layer of 1.8 mm. Cu and a thickness of tissue 20 cm.,

$F = 17.8$

Area of field = $15 \times 15 = 225$ sq. cm.

Dose to field = 300 r_{air}

Substituting these values, we get

Volume dose = $17.8 \times 225 \times 300$

= 1,200,000 cc.-roentgens

1,000,000 cc.-roentgens equals 1 mega cc.-roentgen.

Volume dose = 1.2 mega cc.-roentgens.

This figure may be converted to ergs by multiplying by 109.

Volume dose = $1.2 \times 109 = 131$ ergs.

Several sources of error are present in these calculations. The results are therefore only approximate. For example, the "area of the field" should be theoretically not the area of the flat surface but the area of the tangential spherical surface enclosed by the margins of the beam. The difference between these two areas, however, is less than 10 per cent unless the average diameter of the field exceeds one-half of the treatment distance.[4,12] Also, these values of F should not be applied to fields smaller than about 6×8 cm., to total body irradiation, to very elongated fields or to small thick-

nesses of tissue. (For energy absorption in total body irradiation, see Mayneord.[13,15])

Upper limits to the number of cc.-roentgens which may safely be given within various time intervals to different parts of the body exist but only a few have been estimated. Smithers[17] states that the maximum safe volume dose to the thorax in forty-two days is about 28 mega cc.-roentgens; to the pelvis in thirty-one days, 36 mega cc.-roentgens; to the pelvis in three days, 6 mega cc.-roentgens. A great deal remains to be done before these dosage levels will be known with certainty under various circumstances.

1 East 100 St.
New York 29, N. Y.

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Twenty-eighth Annual Meeting: 1944, to be announced.

EDITORIAL

RADIUM THERAPY, ROENTGEN THERAPY AND THE RADIATION THERAPIST

RADIUM, potentially one of the greatest boons to mankind, has through misuse and abuse failed to fulfill the high hopes the medical profession had for it. *Why* and more important *how* can it achieve its rightful place as a leading therapeutic agent for disease?

A car with perfect brakes, new tires and all the other requisites that are included to make it work does not move when the attempt to drive it is made by a person who does not know how, and is a potential danger in the hands of an inexperienced driver. Such is the story of radium.

All radiological societies and the American Medical Association have gone so far as to refuse commercial radium advertising unless rental or sale is restricted to competent radiologists. Notwithstanding this highly laudable attitude, there has been no abandonment of the unrestricted sale of radium and radon to hospitals without the least regard for the ability or competence of those who might use the radium.

The hospitals have been one of the main factors in lowering not only the status of the radiation therapist but also the value of radium as a therapeutic agent. They are in altogether too many cases indiscriminate in regard to those who may use radium. The hospitals have more and more commercialized radiology in spite of the efforts of the few to fight against this trend. This has produced a disregard for experience, learning and training in radium therapeusis.

Equally culpable is the physician who owns or leases a little radium and then makes it available in return for a financial consideration to any colleague who requests it, regardless of the renter's lack of training and inability to use the radium properly.

Skinner[1] in noting the situation states that while he does not decry the rental of radiant energy to qualified radiologists, he most vehemently assails the propriety of its use by any unqualified physician on an unsuspecting and undiscerning public.

If no more is required than that non-radiologically trained surgeons or physicians make verbal requests for the loan of radium under the perfunctory, casual supervision of a hospital radiologist, radium therapy can scarcely achieve successes. The radium therapist must earn and merit the respect due a competent clinician practicing radium therapy. As Friedman[2] states, "The practice of certifying men in 'Radiology,' who have had little or no experience with radium is to be deplored."

Quick[3] says, "No man should attempt roentgen therapy without a thorough working knowledge of radium. Whether he actually handles the radium himself or not, he should know when and how it should be done. There should be no roentgen therapist, he should be a therapeutic radiologist. The need for this distinction and the need for correction of one sided training, as it too often exists today, has been noted many times in the American Board of Radiology."

McWhirter[4] holds that to carry out radiation therapy properly and evaluate its effects, the therapist should be master of both roentgen and radium radiation. Best results are achieved in large centers, where numerous cases of a given type can be gath-

[1] Skinner, E. H. Introduction to the history of carcinoma of the cervix uteri. *Radiology*, 1943, *40*, 433–435.
[2] Friedman, M. Personal communication.
[3] Quick, D. *New York State J. Med.*, 1944, *44*, 981–985.
[4] McWhirter, R. Some observations in radiotherapy. *Radiography*, 1943, *9*, 41–45.

ered and sufficient experience thereby obtained in recognition, diagnosis and therapy. He doubts that small treatment centers can make any useful contributions to the advancement of knowledge in the cancer field and in fact he maintains that their very existence detracts from the larger centers and makes them less effective. Under the National Cancer Act in Great Britain, the Faculty of Radiologists has advanced a plan for radiotherapy, namely that roentgen and radium therapy must be organized as a single department, completely separated from the department of radiodiagnosis. Experience has shown that where this is not in force radiotherapy is of mediocre caliber, and of secondary importance; especially in the matter of radium therapy, the radiologist is relegated to the side lines and every other specialist does the radium therapy he himself should be carrying out by reason of his training and experience and so make the title of Radiation Therapist significant.

Who is, or rather, who should be a radiation therapist and to whom should radium be entrusted? Is he one of the large group of physicians hastily trained by the Army in the rudiments of diagnostic roentgenology and given only sufficient knowledge for emergency treatment of the wounded? Is he the radiologist who despite his inadequate experience in radium therapy regards himself as a therapist merely because therapy is a sideline for which certification is so easily obtainable? Is he the gynecologist or surgeon who though unqualified undertakes to prescribe treatments because of the lowered status of radiotherapy? Is it any member of the medical staff of a hospital who undertakes treatment with radium simply because of its availability? The answer we believe must be an emphatic "no" in all of the above cases.

We must make certain that a radiation therapist has had sufficient experience during his training with the treatment of various forms of the common lesions such as cancer of the cervix, tongue or tonsil. Familiarity with stated principles does not carry with it knowledge of specific radiotherapeutic implications unless it has been accompanied by participation in the examination and treatment of a large number of cases. For example, it requires experience to differentiate between a papillary and a diffusely infiltrating cancer of the tongue; to perform a vaginal examination and describe the findings; to differentiate between an infiltrating or a non-infiltrating cancer of the lip or skin. What should be the background of the radiation therapist and what should be his position in the medical field?

A certain awareness of the all embracing medical knowledge required by the radiation therapist has existed as evidenced by Skinner's[5] statement in 1933. "I look upon radiology," he said, "as a service department in diagnostics and as an autonomous field in therapy. . . . Roentgen diagnosis, while venturing deep into clinical diagnosis does not carry the essential responsibilities that radiotherapy forces upon the radiologist. . . . The field of radiologic therapeutics, both roentgen and radium therapy, carries a dignity and responsibility that cannot be assailed or absorbed by technician or tyro. The ultimate results of radiologic therapy depend upon the painstaking, thoughtful application of physical and optical laws of radiant energy based upon judgement, backed by experience and warranted by cooperative authority."

What should be the status of the radiotherapist? The position is distinctly a clinical one in medicine and equal to that of the surgeon. In fact, one with good surgical training and experience makes a better radium therapist. The present method, therefore, of certifying radiation therapists does not presuppose a properly trained clinician. There is no substitute for experience and not until certification is based on clinical experience can any examination properly qualify the radium therapist. The radiologist who regards radiation therapeutic practice merely as a sideline to roentgenology may fail to give his patient

[5] Skinner, E. H. Relation of radiology to other fields of medicine. *Colorado Med.*, 1933, *30*, 179–182.

adequate and proper treatment. Actual and potential dangers are likely to appear even when treatment is carried out by the best trained radium therapist. How much more so is the danger aggravated at the hands of the novice equipped only with book-learning, didactic lectures and inadequate observation. Only when the radiation therapist is thoroughly qualified through training and experience to practice radium therapy will progress have been achieved in the interest of the patient under his care.

If just as we entrust the scalpel only to the hands of the surgeon so we entrust radium only to the hands of the radiation therapist, then and then only will radium fulfill all of its promises and the radiation therapist assume his rightful position among those recognized as specialists.

When radiologists as well as physicians realize the importance of radiation therapy as a specialty and demand high standards for those who practice it then will the radiation therapist receive the respect due him and produce the results in service to the patient that only he is potentially capable of giving.

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SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Sept. 18–21, 1945.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: 1945, to be announced.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION
Secretary, Dr. Earl R. Miller, University of California Hospital, San Francisco, Calif.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION
Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Roy G. Giles, Temple, Texas.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N.Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 P.M. at Allerton Hotel on fourth Monday each month, October to April, inclusive.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 P.M.

DENVER RADIOLOGICAL CLUB
Secretary, Dr. Edward J. Meister, 366 Metropolitan Bldg., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY
Acting Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month at a place designated by the president.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meets annually second Sunday in May.

IOWA X-RAY CLUB
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

NEBRASKA RADIOLOGICAL SOCIETY
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pk. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY
Secretary, Dr. Major Fleming, Rocky Mount, N. C. An-

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

nual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

North Dakota Radiological Society
Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

Ohio Radiological Society
Secretary, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. R. P. Barden, University Hospital, Meetings first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Pittsburgh Roentgen Society
Secretary, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

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Secretary, Dr. E. W. Spinzig, 2646 Potomac, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

San Diego Roentgen Society
Secretary, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.

San Francisco Radiological Society
Secretary, Dr. Martha Mottram, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Toland Hall, University of California Hospital, second six months at Lane Hall, Stanford University Hospital.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. Asa E. Seeds, Baylor Hospital, Dallas, Texas. Next annual meeting, Temple, Texas, Jan. 17, 1945.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

Virginia Radiological Society
Secretary, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

X-ray Study Club of San Francisco
Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month at 4:45 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

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All-Russian Roentgen Ray Association, Leningrad: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

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IN ADDITION to the committees of the American Roentgen Ray Society which are carried regularly in the JOURNAL, the following committees have been appointed for 1944–1945:

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DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., B.S., M.A., 103 Rutledge Ave. Charleston, S. C.

DEVICE FOR PREVENTION OF ACCIDENTAL RADIATION OVERDOSAGE DUE TO INCORRECT FILTER-KILOVOLTAGE COMBINATIONS

By M. F. HALL, M.D.
JOPLIN, MISSOURI

ROENTGEN therapy dosage has become so universally controlled by the use of the r-meter, and the tissue tolerance so well established by experience and experimentation, that there is little likelihood of serious overdosage occurring when treatment is administered directly by qualified radiologists using modern equipment. The intended dosage infrequently results in serious damage to normal tissue.

On the other hand, very little progress has been made toward the prevention of accidental overdosage, and each year many such accidents occur. Fortunately, many of the overdosages do not produce serious results. The great majority of overdosages have been due to improper filter-kilovoltage combinations and most radiologists have directly or indirectly had experience with some degree of accidental overdosage.

During the present National Emergency every radiologist has to take care of a larger number of patients, with less technical assistance. In some instances the technical assistants are untrained and inexperienced. These conditions increase the hazard of accidental overdosage and place a greater responsibility upon the radiation therapist.

The greatest danger of accidental overdosage is associated with the use of roentgen therapy machines which may be used with little or no filtration and medium or high kilovoltage.

When applied to machines used for both superficial and deep therapy the device to be described and illustrated positively prevents therapy without filtration when the kilovoltage is higher than that desired for therapy without filter. The selection of kilovoltage for the various filters to be used is done prior to installation. Changes in kilovoltage to be used with any one of the filters can be made later by changing wires leading to the filter selector. If the incoming line current is remarkably unstable it is desirable to have a line voltage compensator such as those used on all roentgenographic machines and some therapy machines. The filter must be correct for the kilovoltage, and vice versa. The timer and roentgen-ray switch will not operate until the filter and kilovoltage are matched.

The greatest possible error to be made while using a machine equipped with such a safety device would be in overlooking both the filtration and kilovoltage. Following a superficial therapy treatment, the therapist could prepare a patient for medium or deep therapy, and in failing to change either the filter or kilovoltage could administer treatment at low kilovoltage without filter for the time intended to give the treatment at higher kilovoltage with heavier filtration. Even conceding this gross double error, the overdosage would amount to only one-fifth to one-tenth that which would occur were it possible to treat at high kilovoltage and no filter for the same length of time.

The device can be installed on any type of roentgen therapy equipment and used as a protection against incorrect filtration-

kilovoltage combinations. Deep roentgen therapy machines can be equipped as well as those used for superficial therapy. The timer is included in the circuit. Otherwise the timer might be turned on without closing the roentgen-ray switch and should the timer automatically release before the therapist or technician noted the open switch, he would not be aware that the patient had not received treatment.

The device should be easily adapted to machines using turret type filter head. When both deep and superficial roentgen therapy machines are used in the same department or office, the deep therapy machine may be allowed a relatively heavy minimum filtration, more filtration being added as desired. The portals having filtration of less than 0.5 mm. Cu plus 1 mm. Al can best be eliminated or changed to heavier filtration. If the machine has a turret type filter head, this is easily done by covering the ports containing aluminum filtration with lead. When this change is made the deep roentgen therapy machine is relatively safe without the safety device. The output using 0.5 mm. Cu plus 1 mm. Al is not enough greater than that through 1 mm. Cu or composite filter to cause serious overdosage from any one treatment. These changes in addition to the safety device installed on the superficial and intermediate kilovoltage machine limit serious error to setting the timer.

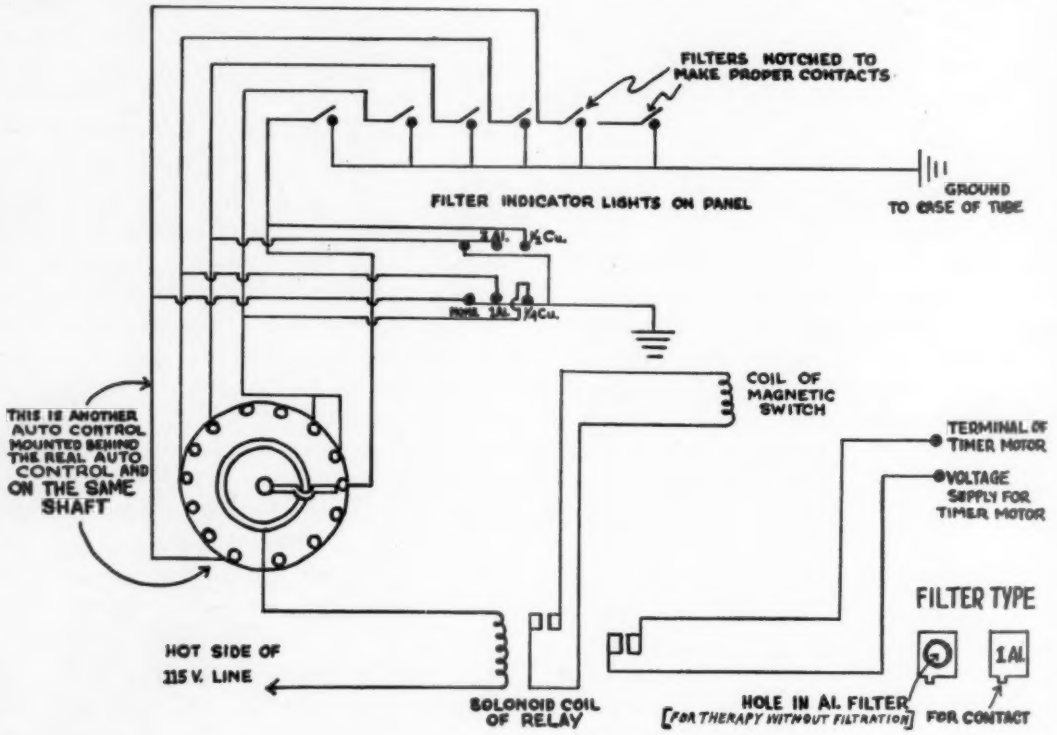
FILTERS NOTCHED TO MAKE PROPER CONTACTS
GROUND TO CASE OF TUBE
FILTER INDICATOR LIGHTS ON PANEL
1 Al. ½ Cu.
NONE 1 Al. ¼ Cu.
COIL OF MAGNETIC SWITCH
THIS IS ANOTHER AUTO CONTROL MOUNTED BEHIND THE REAL AUTO CONTROL AND ON THE SAME SHAFT
TERMINAL OF TIMER MOTOR
VOLTAGE SUPPLY FOR TIMER MOTOR
FILTER TYPE
1 Al
HOT SIDE OF 115 V. LINE
SOLENOID COIL OF RELAY
HOLE IN Al. FILTER [FOR THERAPY WITHOUT FILTRATION]
FOR CONTACT

FIG. 1

The device is relatively inexpensive but requires moderate skill in fitting the contact arms to the tube casing so they will accurately and permanently make contact with contact tongues on the filters. Failure to make contact would not be dangerous since any contact failure prevents operation of the machine. The filters are cut away on one side and a stop placed on the tube head preventing contact should the filter be inserted wrong side up. The same stop and cut away combination are utilized to produce proper tension of the contact arm against the contact tongue on the filter.

Since each filter must have its own kilovoltage, and therapists often use the same kilovoltage with different filters, the circuits may be so arranged that two or more filters are matched to kilovoltages only one step apart, the heavier filter being used with the higher kilovoltage. Thus 0.5 mm. Cu plus 1 mm. Al may be used with 140 kv. and 0.25 mm. Cu plus 1 mm. Al with 135 or 138 kv.

Should the radiation therapist desire to administer a large dosage within a very short time by using high kilovoltage without filter, he could have a master contactor constructed similar to that used in treating without filter at low kilovoltage. This, however, is inadvisable since it introduces a definite hazard. The occasional loss of a few minutes when using a potentially lethal machine is a small price to pay for safety.

The removable combination filters should be riveted together for obvious reasons. As an added safety measure the filter-indicator pilot lights should be placed at eye level to readily attract the operator's attention. Below each pilot light a small drawer index frame may be attached to hold a card giving the r-output at various distances for the filtration indicated.

It has been found after several months' use that the device does not in any way interfere with applying the roentgen-ray beam to the treatment area and has, to date, required no electrical or mechanical service.

SUMMARY

A safety device for use on roentgen therapy machines has been described and illustrated. It will positively prevent administration of treatment at higher kilovoltages without proper filtration. It is intended and believed to be an absolute protection for the patient against accidental overdose due to incorrect filter-kilovoltage combinations. In using it, the radiologist finds his work easier and fraught with less apprehension.*

622 Frisco Building
Joplin, Missouri

* The cooperation of the General Electric Company in helping to install the device is acknowledged.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

NECK AND CHEST

Gartside, V. O. B. Agenesis of the lung. *Brit. J. Radiol.*, March, 1943, *16*, 69–71.

A child seven years of age was first sent for examination at the age of five because of a swelling of the neck. When sent for examination this time he had no serious illness but the mother reported that he easily got cold on the chest. Roentgen examination showed the left bronchus only about half its normal length. It tapered abruptly and ended in a small bronchus that had many slender twigs supplying a wedge-shaped segment of normal lung tissue that lay immediately above the dome of the diaphragm. The fine bronchi in this area seemed to be normal.

Thirty-four cases of agenesis of the lung had been described up to 1937. The children affected generally die of asphyxia at birth. The condition is frequently associated with other abnormalities and in the case described above there were spina bifida, wedge-shaped vertebrae, cervical ribs, fusion of ribs, congenital high scapula and a congenital heart lesion, probably a defect of the septum.

The condition is probably due to some developmental defect in the germ-plasm.—*Audrey G. Morgan.*

Evans, William A., Jr. Echinococcus cyst of the lung. *Radiology*, April, 1943, *40*, 362–366.

Echinococcus disease is rare in North America but very prevalent in Australia, Iceland, North Africa and South America. Under war conditions, therefore, it would be well for American physicians to be thoroughly grounded in the roentgen signs of the disease.

A case in an Italian boy twelve years of age is described and illustrated with roentgenograms. The boy had lived in Italy for seven years. He had pain in the left chest and a non-productive cough. He had had a similar attack a year before. Roentgen examination March 16, 1942, showed a sharply circumscribed shadow of uniform density except for a capsule at the periphery with a layer of air between the capsule and the mass. A presumptive diagnosis of benign tumor was made. On re-examination a week later after a diagnostic pneumothorax the air beneath the capsule was no longer seen. On operation April 4, 1942, a hydatid cyst was removed. Recovery was uneventul.

This finding of air between the parasite and the adventitia is a pathognomonic sign at a certain stage of echinococcus cyst of the lung. A diagram is given of the appearance in the different stages of development of the cyst. In stage 1 there is a rounded shadow of uniform density which cannot be differentiated from that of tumor. In stage 2 air has entered the space between the adventitia and the hydatid vesicle, giving the pathognomonic picture seen in the above case. In stage 3 there has been further separation of the cyst and adventitia and disintegration of the cyst has allowed the cyst fluid to leak into the pericystic space. This is called Cumbo's sign or the double arc sign of Ivanissevich. In stage 4 the cyst has collapsed completely and the retained membrane floats on the cystic fluid giving the water-lily sign of Segers and Lagos Garcia.—*Audrey G. Morgan.*

Rigler, Leo G. The infected lung cyst. *Radiology*, May, 1943, *40*, 485–496.

Cysts of the lung are not uncommon and their correct diagnosis has become increasingly important since developments in surgery have made it possible to cure them permanently. As the true lung cyst develops from a bronchial bud it is commonly lined with epithelium. This makes it possible to make a diagnosis by biopsy on draining the cavity. The demonstration of bronchial epithelium makes differentiation from abscess or encapsulated empyema possible. If a supposed empyema fails to clear up on drainage it also indicates cyst of the lung. These cysts, of course, may readily become infected through a communication with the bronchus.

Five cases which illustrate different phases of the problem of lung cysts are described and illustrated with photographs and roentgenograms. The first is a case of the development of a bronchial fistula in a cyst filled with fluid.

The second is one of multiple infected cysts of the lung which simulated loculated empyema or lung abscess. The third was a single large cyst of the lung which had been mistakenly diagnosed as encapsulated empyema but repeated rib resections with drainage had failed to cure the patient. The fourth was one of congenital gas-filled cysts of the lung which later in life had become infected and developed into pockets containing pus which simulated lung abscesses. The fifth was a case of single infected cyst of the lung which had been diagnosed as encapsulated empyema but which had failed to clear up after several rib resections. The correct diagnosis was made by roentgen examination and confirmed by biopsy.

The most important roentgen signs of infected cyst are the sharply encapsulated, well defined pocket standing out separately from the remainder of the chest, the absence of associated pleural thickening, the frequently very low position of the pocket, the absence of any retraction of the mediastinum or diaphragm toward the encapsulated pocket, and the demonstration of a relatively thin wall when air replaces the fluid in the pocket; also the demonstration of trabeculae inside the cyst representing strands of lung tissue.

Such cysts can be permanently cured by radical surgery, preferably lobectomy of the lobe containing the cyst.—*Audrey G. Morgan.*

BELL, E. T., RIGLER, LEO G., SPINK, WESLEY, and Watson, C. J. [Carcinoma of right lower lobe bronchus with metastasis to apex of right lower lobe and extension into mediastinum.] *Radiology*, June, 1943, *40*, 594–598.

At this conference a case was discussed which shows the difficulty encountered in the early diagnosis of bronchogenic carcinoma. The patient was a man of sixty admitted to the hospital July 9, 1942, after a study in the outpatient department two weeks before. He complained of weakness, anorexia, loss of weight and dry cough, all beginning in March. His sputum had become purulent and his breath bad but there was no hemoptysis. He had marked clubbing of the fingers, no cyanosis. Atypical acid-fast bacilli were found in the sputum and stomach washings. The roentgen examination indicated peripheral carcinoma, primary in the apex of the right lower lobe with metastasis to the peribronchial lymph nodes at the right hilum and infiltration about the lower lobe bronchus. The patient improved on rest in bed and that, together with the finding of acid-fast bacilli, suggested tuberculosis and made it necessary to wait for the results of guinea pig inoculation. Biopsy also failed to show positive evidence of tumor.

The patient died on September 20 and the autopsy confirmed the roentgen findings. There was a primary ulcerating adenocarcinoma of the right lower lobe bronchus extending to the surrounding lung and up to the carina and a metastasis in the apex of the lower lobe. It was so extensive that pneumonectomy would have been impossible, but in similar cases the evidence of tuberculosis may cause fatal delay in operation.—*Audrey G. Morgan.*

RHOADS, PAUL S. The probable incidence and clinical features of "virus" pneumonia. *Radiology*, April, 1943, *40*, 327–338.

Cases of atypical primary bronchopneumonia have increased greatly in the United States in the past two years. They probably outnumber cases of pneumococcus pneumonia about 4 to 1. It is impossible for the general practitioner to demonstrate virus in these cases so it is probably better to give them the above name, though there is experimental evidence of their causation by virus. Lacking laboratory confirmation, however, the general practitioner must diagnose them from the physical signs. Among these are the scanty physical signs and the mildness of the disease as compared with pneumococcus pneumonia.

The author studied 31 cases observed between August, 1941, and December, 1942. Case reports and roentgenograms of 7 of the cases are given. The comparative mildness of the clinical symptoms is shown by the fact that the average time before the patients reported for treatment was 5.92 days. In these cases the average leukocyte count was 10,600 and the average duration of fever 16.2 days as compared with an average leukocyte count in the pneumococcus cases studied during the same period of 20,300 and an average duration of fever after the beginning of treatment of 5.1 days. The pulse, as a rule, was low as compared with the fever. The temperature range was usually 102° to 104° F. for the first ten days with a gradual fall by lysis. In severe cases with moisture the pulse was usually high. Oxygen was used on all of the patients who had "wet" lungs or cyanosis from any cause. Usually roentgen examination was required to demonstrate consolidation in the beginning as the physical signs were slight

for the first week. The sulfonamide drugs have no affect in this disease. The only serious complication seen in the author's cases was pleurisy with effusion in 2 cases.

Secondary infection is important and the author thinks will become increasingly so as the epidemic advances. In his 1 fatal case secondary infection with *Streptococcus viridans* evidently contributed to the patient's death. A careful study should be made of the bacterial flora of the sputum, nose and throat in order that autogenous vaccines may be made. The use of convalescent whole blood or serum will probably prove useful.—*Audrey G. Morgan.*

Saphir, Otto. Pathological changes in so-called atypical pneumonia. *Radiology*, April, 1943, *40*, 339–343.

The atypical or virus pneumonia so prevalent at the present time differs quite markedly from pneumococcus pneumonia. Clinically, it is relatively benign and specific pneumococci or other organisms that might have caused it cannot be demonstrated. Roentgenologically lesions appear rapidly in various lung fields and disappear quickly. The interstitial nature of the disease was first demonstrated by roentgenologists who called it acute pneumonitis.

The author describes 2 cases that came to autopsy and illustrates them with photomicrographs of the findings. Virus studies were not made so it is impossible to say definitely that they were cases of virus pneumonia, but it seems probable. Virus studies are very difficult for not only must a virus be demonstrated but it must be proved that the disease is caused by the virus and not by any associated bacteria, and in animal studies it must be proved that the disease is caused by the human virus and not by one indigenous to the laboratory animal.

Interstitial pneumonia has long been known to occur in association with infectious diseases caused by viruses, such as measles, and it is probable that the initial stage in the influenza epidemic of 1917–1918, which is now thought to have been caused by a virus, was an interstitial pneumonia. The interstitial changes, together with the enlargement of lymph nodes, give rise to dyspnea and cyanosis which are characteristic of severe cases of the disease. The interstitial changes may spread and involve the alveoli. A characteristic feature is the hyalin-like ring that forms the inner lining of many alveoli. The exudate differs from that of lobar or bronchopneumonia in being made up mostly of mononuclear cells. The usual varieties of virus pneumonia now seen are not very severe and therefore autopsy material is not abundant; therefore the importance of describing the author's 2 autopsy cases even though virus studies had not been made. He concludes that the causative agent was a rickettsial body or virus.—*Audrey G. Morgan.*

McCarthy, Paul B. Primary atypical pneumonia of unknown etiology. *Radiology*, April, 1943, *40*, 344–346.

The author has seen 590 cases of this condition and considers it a disease entity. The mortality is low. In only 1 of his cases did autopsy show atypical pneumonia to have been the primary cause of death. The patients as a group have not been very sick, though a few have been as ill as with a severe pneumonia. He has found that keeping the patient in the hospital till the chest roentgenogram is relatively clear decreases the chance of recurrence.

Evidence of the disease appears on chest roentgenograms about the fourth day. The findings vary and the cases have been divided into four groups. In the first and largest group the first signs are an increase in the size of the hilar shadow and a generalized increased prominence of the lung markings. There is definite evidence of pneumonic density of one or more lobes which has apparently spread from the hilar region. The density is less than that of lobar pneumonia. In group 2 there is a patchy involvement, usually of only one lobe, suggestive of bronchopneumonia. There is very rapid resolution in this type. In the third group there is extending infiltration radiating from the hilar region and later involving a whole lobe. This type is almost indistinguishable from tuberculosis. In group 4 there are increased lung markings throughout with small parenchymal areas of infiltration somewhat resembling miliary tuberculosis. The patients in this group are very sick and the course of the disease is long. The distinction between an atypical pneumonia of the upper chest and tuberculosis is difficult.

Four cases, one from each of the four groups, are described and illustrated with roentgenograms.—*Audrey G. Morgan.*

Curtzwiler, F. C., and Moore, B. E. Primary atypical pneumonia of unknown etiology. *Radiology*, April, 1943, *40*, 347–350.

The authors came into contact with this disease at Camp Davis, North Carolina, when

they interpreted minimal changes in one of the upper lobes near the periphery as tuberculosis and found that they cleared up in a few days. On further study they came to recognize the clinical and roentgen findings of primary atypical pneumonia, and state the conclusions they have reached from an examination of over 100 cases. They believe that both clinical and roentgen examination is necessary for diagnosis. The chief symptoms are general malaise, weakness, non-productive cough, fever and general aching. Early in the disease there are no physical findings, later there are coarse râles over the whole chest. The white cell count is normal in the beginning and later may rise to 14,000 to 15,000. Leukopenia has not been seen. The disease does not respond to chemotherapy. The laboratory findings are helpful only in a negative way. The few bacteria found have not been thought to be the cause of the disease. The pulse is relatively low. The temperature may reach 104° F., while the pulse rate has been 90 to 100 per minute.

They believe attention has been called to this disease recently by the mass examinations of the chest for tuberculosis. The roentgenogram most frequently shows a thickening of one or both hilar shadows and a patchy type of peribronchial increased density along the basilar branches of one of the lower lobe bronchi. The patches may become confluent, occasionally to such an extent that it looks like lobar pneumonia. There may be thickening of the pleura over the involved lobe, causing a shadow resembling lobar pneumonia, but this disease can be ruled out by the clinical findings and the white blood count. Examination during resolution again shows a peribronchial type of patchy infiltration. In the central type a lateral projection often shows lesions along the bronchus dorsalis which supplies the apex of the lower lobe. But when this bronchus is involved the patches generally become confluent.

The authors give a warning against interpreting this disease as tuberculosis in the interpretation of survey roentgenograms.

The patients are generally incapacitated for two to three weeks. If discharged too early there is apt to be recurrence. No serious sequelae or complications have been seen. Treatment is symptomatic.—*Audrey G. Morgan.*

HUFFORD, C. E., and APPLEBAUM, A. A. Atypical pneumonia of probable virus origin. *Radiology*, April, 1943, *40*, 351–361.

There has been enough evidence of primary infective non-bacterial pneumonia to establish it as a clinical entity. There has been considerable success in the isolation of a psittacosis or related virus in some cases.

The authors discuss 27 cases that they have seen, with case histories and roentgenograms of 5 cases belonging to three typical groups of mild, severe and migrating. The latter spreads rapidly from one area to another. There was only 1 death among the 27 cases.

The clinical symptoms are sore throat, severe headache, generalized aching, drenching sweats and severe paroxysmal coughing. There have been few physical findings except moist râles at the bases posteriorly. The leukocyte count was low, sometimes showing leukopenia. Sputum examination failed to show any bacteria responsible for the disease and typing with pneumococcus serum was negative. The cases did not respond to sulfonamide treatment.

The roentgen findings are of great value in diagnosis but require the support of clinical evidence. Without it they might be mistaken for tuberculosis. The typical roentgen picture is that of diffuse, irregular, patchy densities with feathery edges extending out from the hilum. There is generally some coalescence but large areas of consolidation are rarely seen.—*Audrey G. Morgan.*

HILLEBOE, HERMAN E. Use of small x-ray films in tuberculosis control. *Radiology*, March, 1943, *40*, 297–301.

Mass examinations for tuberculosis became increasingly important with the advent of war. All recruits for the Army and Navy are now tested and similar examinations will soon be made of Coast Guard recruits. But it is also increasingly important to examine the civilian population as the danger of tuberculosis is increased by large-scale concentrations of industrial workers and their families, employment by industry of thousands of women and other workers who are not accustomed to heavy labor and fatigue and insufficient rest as a result of the heavy demands of the work.

Examination with the ordinary 14×17 inch film is too expensive and too time consuming for this work. The use of 35 mm. photofluorograms has been substituted in mass examinations because of its cheapness and rapidity. The Office of Tuberculosis Control has established eight survey units for this purpose which are now loaned to industries free of cost. Each is in

charge of an officer of the United States Public Health Service who is a specialist in the interpretation of 35 mm. films. It has been demonstrated that less than 10 per cent of cases with minimal lesions are missed. As only about a third of these are found significant the percentage is really nearer 3 per cent. With adequate treatment facilities tuberculosis can easily be controlled if this percentage of early cases can be detected.

The purpose of the small film examination is not to diagnose tuberculosis but to screen out cases with slight lesions for further examination. All abnormal or suspected cases are re-examined with large films. In the course of the tuberculosis examinations other unsuspected pathological conditions are often discovered.—*Audrey G. Morgan.*

ABDOMEN

Ross, John A. A note on amoebic hepatitis. *Brit. J. Radiol.*, Jan., 1943, *16*, 30.

A raised dome of the diaphragm suggests amebic hepatitis if the patient has been abroad. Sometimes patients complain only of slight tenderness in the right hypochondrium; there is only slight rise of temperature and a history of diarrhea. The liver may be enlarged upward and not palpable in the abdomen. Screen examination may show decreased movement of the right or left domes of the diaphragm. The raised dome may show an abnormal outline due to the amebic abscess. The lungs may show congestion with or without effusion. Usually the right dome is raised and the lung signs are at the right base. After emetine treatment the diaphragm resumes its normal position. Roentgengrams should be made so that the excursion of the diaphragm can be measured before and after treatment. Details of the method of taking the roentgenograms are given.—*Audrey G. Morgan.*

Elkeles, A., and James, J. I. P. Calcified non-parasitic cyst of the spleen. *Brit. J. Radiol.*, Feb., 1943, *16*, 59–60.

Non-parasitic cysts of the spleen are rare, only 137 having been reported up to 1939. A case is reported in a soldier, aged forty-one, who complained of sharp, jabbing pain in the left hypochondrium, which he had had for about fourteen weeks. For a number of years he had had attacks of vomiting after meals and about twenty-five years ago had had an attack of what appeared to be acute catarrhal jaundice. No history of injury.

A plain roentgenogram of the abdomen showed a large round cyst the size of an orange in the left upper quadrant. Its outline was distinct and it was calcified. Its upper pole was in contact with the left diaphragm which was slightly elevated. On roentgenoscopic examination the cyst moved with the restricted movement of the diaphragm on respiration. After a barium meal the stomach was displaced to the right and the cyst lay above the splenic flexure which was pushed downward. The left kidney was displaced downward. Operation showed the spleen enlarged with a calcified cyst at the upper pole. Recovery was uneventful.—*Audrey G. Morgan.*

Zwerling, Henry, and Nelson, Waldo E. The roentgenologic pattern of the small intestine in infants and children. *Radiology*, March, 1943, *40*, 277–282.

Certain variations from what is considered normal have been found in the roentgen picture of the small intestine in children with nutritional deficiency, such as coarsening or obliteration of the mucosal markings, segmentation, irregular flocculation and in some cases dilatation. In gastrointestinal allergy the pattern is that of hypertonicity with narrowing of the lumen. But a similar intestinal pattern has been found in normal newborn infants and it has been claimed that the transition from the infantile to the adult pattern occurs at the age of four to five months.

The authors examined 77 children from three months to eleven years old. Twenty were from a well baby clinic, 45 from an orphanage and 12 from families in good economic circumstances.

Barium was given and roentgenograms taken thirty minutes later and after that at intervals of thirty to sixty minutes until the barium had passed to the distal ileum or cecum. The roentgenograms are reproduced. The only child who showed a definitely adult type of marking was the one that had a nutritional disturbance. All of the signs described above as being infantile or due to deficiency states were found in varying degrees in the majority of cases. Apparently a diagnosis of deficiency states in children cannot be based on the roentgen appearance of the small intestine.—*Audrey G. Morgan.*

Jackman, Raymond J., and Smith, Newton D. Some manifestations of regional ileitis observed sigmoidoscopically. *Surg., Gynec. & Obst.*, April, 1943, *76*, 444–445.

Ever since Crohn and his co-workers established regional ileitis as an entity in 1932, the authors have been impressed with the frequency of certain anorectal manifestations of the disease. The records of 114 consecutive cases of regional ileitis in which the diagnosis was made by roentgenologic examination and confirmed by exploration were reviewed. Sigmoidoscopic examinations were done on these cases. The purpose of the review was to note the lesions of the lower part of the bowel which are more or less peculiar to the disease.

Anal Abscess and Anal Fistula. Thirty-six, or 31.6 per cent of the 114 patients, had anal abscess or anal fistula, or they gave a history of having had an operation for anal fistula within a period of three years prior to their visit to the Mayo Clinic. With increased alertness to the possibility of coexistence of the two conditions, even more cases of regional ileitis could be found among patients whose primary complain is anal abscess or anal fistula.

Extrarectal Mass. A mass was palpable in the rectovesical or rectouterine space in 20, or 17.5 per cent of the 114 cases. This mass represents an involved segment of diseased ileum, perhaps complicated by pelvic peritonitis and diffuse fistulous tracts.

Anal Ulceration and Anal Contraction. Nine, 7.8 per cent, of the 114 patients studied had anal ulcerations or anal contracture.

Ulceration in Lower Part of the Bowel after Short Circuiting Operations. On sigmoidoscopic examination of 4 patients (3.5 per cent of the group) one to two years after short circuiting operations, ulcerations were found in the lower part of the bowel.—*Mary Frances Vastine.*

HELWIG, ELSON B. Benign tumors of the large intestine—incidence and distribution. *Surg., Gynec. & Obst.*, April, 1943, *76*, 419–426.

This report is based upon 1,460 consecutive autopsies in which the entire large intestine was available for study. The study is from the Department of Pathology, Washington University School of Medicine, St. Louis.

The number of cases and the various types of polyps encountered in the large intestine in this series are as follows:

1. *Adenomas.* There were 139 adenomas, an incidence of 9.5 per cent. In 80 instances there were single adenomas and in 59 cases 2 or more adenomas were present. The sigmoid colon is the most common site in the large intestine for the occurrence of adenomas. The adenomas may be either sessile or pedunculated. A few were as small as 1 mm. in diameter and the largest measured 9 cm. in the greatest diameter.

2. *Lipomas.* In the 1,460 consecutive large intestines, 13 contained lipomas, an incidence of 0.89 per cent. Ten showed a solitary lipoma and 3 contained 2 or more. Ten of the lipomas were located in the large intestine, an incidence of 0.25 per cent. The cecum and the contiguous ascending colon are the most common sites of lipomas in the large intestine. Lipomas of gastrointestinal tract are about equally divided in the sexes. The incidence of lipomas is greatest in the same decades in which adenomas and carcinomas are most common, i.e. in patients over fifty years of age.

3. *Leiomyoma.* Only 1 tumor composed of smooth muscle was encountered in this series of 1,460 autopsies. It was located in the sigmoid colon of a man aged sixty-seven.

4. *Carcinoid.* The fourth type of polyp encountered in this series was the carcinoid or argentaffinoma. It occurs most commonly in the appendix and less frequently in the ileum. It is a decidedly uncommon tumor. In the present report the tumor was located in the rectum of a man fifty-six years old.—*Mary Frances Vastine.*

GYNECOLOGY AND OBSTETRICS

DICKINSON, KENNETH, and PROCTER, IVAN M. Comparative measurements of the female pelvis. *Am. J. Obst. & Gynec.*, Oct., 1942, *44*, 585–591.

This study is undertaken with the purpose of comparing the anteroposterior diameters of the pelvis obtained by the four methods which can be used: (1) The diagonal conjugate may be obtained and the true conjugate estimated from it by subtracting 1.5 to 2 cm. (2) Roentgen rays may be directed into the pelvic inlet by the technique of Thoms, Torpin, and others. (3) Roentgen rays may be directed lateral to the pelvic inlet by the technique of Thoms, Jacobs and others. (4) The patient may be operated upon and the true conjugate measured directly.

Results of Comparative Measurements.

In 83 per cent of the cases the anteroposterior view compared favorably with the lateral view, i.e. the anteroposterior diameter was the same in both, allowing an error of 4 mm.

In 40 per cent of the cases measured by the first roentgen-ray technique and in 41 per cent of the cases measured by the second roentgen-ray technique, the operative and roentgen-ray measurements were the same. This is not a high

degree of accuracy. The disagreement in the remaining 60 per cent may be explained by the fact that the roentgen ray measures bone-to-bone only, and any other technique, including the measurements made at the time of operation, includes soft tissue-to-soft tissue measurement.

One subtracts 1.5 to 2 cm. from the diagonal conjugate to obtain the true conjugate. The diagonal conjugate and the true conjugate measured by the roentgen ray and at the time of abdominal operation were compared. The figures obtained would seem to show that so far as the clinical evaluation of the pelvis is concerned one would be nearer correct in 80 per cent of these cases if the unmodified diagonal conjugate were accepted as the same as the roentgen-ray true conjugate.—*Mary Frances Vastine.*

Steele, Kyle B., and Javert, Carl T. Classification of the obstetric pelvis based on size, mensuration, and morphology. *Am. J. Obst. & Gynec.*, Nov., 1942, *44*, 783–798.

In this communication the authors consider the classifications of the obstetric pelvis as well as the methods of diagnosis and a method of approach is outlined which combines the best features of each. They conclude that:

(1) Size and morphology constitute the most practical basis for classification of the obstetric pelvis.

(2) Mensuration, utilizing roentgen pelvimetry, serves primarily to determine size. Size is an index of morphology in an unusually large percentage of contracted pelves which are often of the android, platypelloid, or small gynecoid types.

(3) Roentgen pelvimetry in 1,000 cases has demonstrated that 30 per cent were contracted in contradistinction to an incidence of 15 per cent detected by clinical pelvimetry.

(4) Morphology can be most easily and most accurately determined by the direct study of form using the precision stereoscope.

(5) All forms encountered must be provided for in a formal classification. The terminology of Caldwell and Moloy has been employed because it provides for the recognition of pure and mixed types. The terms have correct etymology. Care must be utilized when combining their nomenclature with that of Thoms. While the terms "dolichopellic" and "anthropoid," "platypellic," and "platypelloid" are interchangeable, there is still some question regarding the admissibility of doing so with the "brachypellic" and "gynecoid," and the "mesatipellic" and "android" types.

(6) The problem presented by the irreducible multiplicity of form can be lessened by individual classification of the anterior and posterior segments of the inlet.

(7) The combined isometric and stereoscopic technique provides an excellent opportunity for the determination of size and for the study of morphology of the obstetric pelvis.

(8) Clinical pelvimetry, using revised concepts, has shown considerable promise and is being investigated further. In this, the posterior transverse diameter should prove of assistance in detecting the android posterior segment.—*Mary France Vastine.*

Lechenger, G. C. Roentgen pelvimetry and fetometry: a new formula. *Radiology*, June, 1943, *40*, 589–593.

In May, 1941, Dippel and Delfs published an article on "The accuracy of roentgen estimates of pelvic and fetal diameters." They criticize methods formerly in use and suggest a method of their own based on the familiar stereoscopic tube shift technique. They use a marker or template of known length placed so that its image will appear on each of the stereoscopic films.

The author suggests a method based on their technique which reduces the problem of pelvimetry and fetometry to a single formula. Diagrams and mathematical formulae used in its application are given. He gives full credit to Dippel and Delfs. His experience has shown the practicability of the method and Dr. Dippel has checked the mathematics and used the method clinically in a number of cases. He reports that the results have been accurate and the application of the method not difficult. It is not necessary for the patient to assume any unusual or uncomfortable position. If there is an evident error the calculations can be rechecked without making any further roentgenograms.—*Audrey G. Morgan.*

Morton, Daniel G. Observations of the development of pelvic conformation. *Am. J. Obst. & Gynec.*, Nov., 1942, *44*, 799–819.

The direct study of 27 fetal pelves of various ages and the roentgenometric study of 143 children of both sexes, from three to seventeen years of age, revealed the following interesting observations:

The Shape of the Pelvic Inlet. (1) The shape of the inlet was found to be broader than long at all periods of *fetal life*; (2) the inlet was still either broader than long or round in most instances in *children under six years of age;* (3) the pelvic inlet was invariably longer than broad *from six to eleven years of age;* (4) the outline of the pelvic inlet was not smooth but showed an inward bowing in the acetabular regions in all of the *children of prepuberty age;* (5) the pelvic inlet of the female pelves showed a tendency to flattening so that many of them again become broader than long *after puberty*. The bowing in the acetabular regions was not noted in the postpuberty group or in the fetal pelves.

Sex Differences. (1) No significant sexual differences were observed in the *fetal period;* (2) only two possible differences were revealed in the *years before puberty:* (a) a shorter posterior segment at the pelvic inlet in the male and (b) a downward angulation of the sacrum in the male; (3) the well-known characteristics of the adult male and female pelves were observed *after puberty.*—*Mary Frances Vastine.*

BAYLIN, GEORGE J., and LAMBETH, SAMUEL S. Roentgen diagnosis of placenta praevia. *Radiology*, May, 1943, *40*, 497–500.

Vaginal bleeding is quite common in the last third of pregnancy and the possibility of placenta previa must always be considered. The dangers of determining the position of the placenta by pelvic examination are obvious. These can be obviated by the use of soft tissue roentgenography. Snow takes three films of all late pregnancy cases, the conventional anteroposterior and lateral roentgenograms plus a soft tissue lateral view. He injects 200 cc. of air into the bladder to afford greater contrast between the placenta and the surrounding tissues.

The technique for taking soft tissue roentgenograms is not difficult and does not require elaborate equipment. A low kilovoltage with relatively short exposure time gives roentgenograms of sufficient contrast to make the anatomical structures visible. The wall of the uterus and the mother's abdominal wall can be seen easily and as the placenta generally occupies 20 to 30 per cent of the surface of the endometrium it also can be identified readily. It appears as a thickened soft tissue shadow fused with the wall of the uterus. A thorough knowledge of the normal structures is necessary for accurate roentgen diagnosis. Air in the bladder has proved helpful according to one observer but it is not necessary. The chief causes of inaccurate visualization seen by the author have been hydramnios, multiple pregnancies, breech presentations and poor films.

Illustrative roentgenograms are given.—*Audrey G. Morgan.*

SKELETAL SYSTEM

BUDD, JOHN W., and MACDONALD, IAN. A modified classification of bone tumors. *Radiology*, June, 1943, *40*, 586–588.

This modified classification of bone tumors is presented by the Los Angeles Tumor Institute. It is based on the histogenetic origin of the tumors, the type of tissue from which they are derived. There has previously been great carelessness in the use of words in the classification of these tumors. For instance, the word osteogenetic has been used loosely to mean tumors derived from bone or tumors which produce bone. The authors think it should be used to indicate only tumors originating in bone, regardless of whether they produce bone or not. They also think that the fact should be recognized that connective-tissue sarcomata of bone are divisible into three main types and that fibrosarcoma should rank as equivalent to osteosarcoma and chondrosarcoma, though less frequent. The classification is as follows:

Type of tissue	Malignant	Benign
1. Connective	Osteosarcoma, Chondrosarcoma, Fibrosarcoma (Osteogenic sarcoma)	Osteoma, Chondroma
2. Undetermined	Malignant giant cell tumor	Benign giant cell tumor; Epiphyseal chondromatous giant cell tumor
3. Endothelial	(a) Angio-endothelioma	(a) Plexiform angioma
	(b) Diffuse endothelioma (Ewing's sarcoma)	(b) Cavernous angioma
4. Hematopoietic		
Erythropoietic	(a) Erythrocytoma	
Myeloid	(b) Myelocytoma; myeloma	
Lymphoid	(c) Lymphocytoma	
Reticular	(d) Reticulocytoma	
5. Adipose	Liposarcoma	

—*Audrey G. Morgan.*

HALDEMAN, KEENE O. Development of bone in relation to the formation of neoplasms. *Radiology*, March, 1943, *40*, 247–252.

The author discusses a theory of the formation of bone tumors for which he gives chief credit to Geschickter and Copeland, who first stated it in their text on "Tumors of Bone."

In the embryo, bones are formed by the differentiation of mesenchymatous cells. The bones of the face and vault of the skull ossify directly from the mesenchyme. In all other bones the development of bone is preceded by that of hyaline cartilage. Up to about the age of twenty-one a plate of hyaline cartilage remains between the epiphysis and shaft of the bones from which growth of the bone takes place. Most bone tumors, either benign or malignant, begin at the site of transition from cartilage to bone. The tumor cell may resemble precartilaginous connective tissue, the cartilage cell or the osteoclast and osteoblast which bring about the actual formation of bone. Bone tumors are not the result of the failure of the process of bone repair to be arrested, that is, they do not result from trauma and fracture, but result from a distortion of the normal process of the change from cartilage to bone.

In the discussion Dr. Bromer presented the arguments for the action of trauma as one of the factors in producing tumors of bone.—*Audrey G. Morgan.*

Luck, J. Vernon. A correlation of roentgenogram and pathological changes in ossifying and chondrifying primary osteogenic neoplasms. *Radiology*, March, 1943, *40*, 253–276.

Correlation of the findings of clinician, pathologist and roentgenologist is of vital importance in the study of bone tumors. Neither one alone can solve all the complicated problems involved in the study of these neoplasms.

This discussion is limited to bone tumors which produce bone or cartilage. The benign forms include osteomas, spongy, eburnated and osteoid, chondromas, solitary and multiple and osteochondromas, solitary and multiple hereditary. The malignant tumors are osteogenic sarcomata, including osteoblastic sarcoma and chondrosarcoma, the former subdivided into sclerosing and osteolytic and the latter into primary and secondary. Giant cell tumors, multiple myelomata and endothelial myelomata are excluded because they do not produce bone or cartilage. Osteogenic fibromata and fibrosarcomata have been known to produce bone and cartilage but they do it so rarely that they too are excluded.

The different types of tumor that are included are taken up separately and a wealth of detail in regard to the roentgen findings given; the article is illustrated with photomicrographs and roentgenograms of the different types of tumor, from a study of which an idea can be obtained of the correlation between the roentgen and pathological findings.—*Audrey G. Morgan*

Shackelford, Richard T., and Brown, Webster H. Osteochondroma of the coronoid process of the mandible. *Surg., Gynec. & Obst.*, July, 1943, *77*, 51–54.

Two cases of osteochondroma of the coronoid process of the mandible are reported. The authors could find no previous reports in the literature of osteochondromas occurring in this particular location. In neither of these 2 cases did routine examination by roentgenograms show the tumor or else its true nature went unrecognized. In the discussion of osteochondromas, the following points are noted:

1. In general, osteochondromas are common tumors appearing usually between the ages of ten and twenty-five years; but some are thought to be congenital.

2. They are benign.

3. They frequently occur near the ends of the long bones, particularly at the site of attachment of the tendon which supplies the maximal degree of traction. A possible reason for this characteristic location is that at such a point a defect in the periosteum permits precartilaginous blastomas to escape or to be pulled out from the limiting membrane and in time these cells produce the osteochondroma.

4. The tumor characteristically has a stalk of normal appearing bone which terminates in a mushroom-shaped head that is capped with a layer of cartilage.

5. The tumors described in this paper were situated on top of the coronoid process, the site of insertion of the powerful temporal muscle. Except for this unusual location they were similar, pathologically and in rate of development, to osteochondromas found elsewhere.

6. A roentgenogram of one of the cases reported reproduced in the article depicts expansion of the coronoid process and erosion of the zygomatic arch. In order to obtain this view it is necessary that the patient's head be partly rotated and the rays directed tangentially to the side of the head. The exact amount of angulation can be estimated after the taking of scout films and fluoroscopic examinations of the head and face. This projection produces some distortion but does supply the maximum amount of detail.—*Mary Frances Vastine.*

FURST, NATHAN J., and SHAPIRO, ROBERT. Polyostotic fibrous dysplasia: review of the literature with two additional cases. *Radiology*, May, 1943, *40*, 501–515.

In Recklinghausen's monograph on fibrocystic disease of bone published in 1882 it is evident that he described a number of unrelated pathological conditions which have in common only the occurrence of fibrocystic-like bone changes. Some of these cases may have been ones of polyostotic fibrous dysplasia. A knowledge of this disease was first popularized in this country by the work of Albright and his coworkers in 1937 and Lichtenstein in 1938. It is characterized by endocrine dysfunction, pigmentation and precocious puberty associated with polyostotic fibrous dysplasia. Its etiology is not definitely known. The various theories in regard to it are discussed and the conclusion reached that it is probably due to some hypothalamic lesion in the region of the third ventricle which produces secondary lesions in the anterior lobe of the pituitary, resulting in abnormal stimulation of its hormones.

Clinical diagnosis is impossible without roentgen examination. There is some tendency for the bone changes to be unilateral, though they may be bilateral. There is no generalized decalcification; the lesions are spotty, with normal bone between diseased areas. The characteristic lesions are areas of rarefaction resembling bone cysts, but they are not true cysts. The roentgen appearance is due to the replacement of bone by fibrous tissue. There are also areas of increased density. There is marked thinning of the cortex with broadening or expansion of the diseased bones. Periosteal reaction rarely occurs except at the site of fracture. Pathological fractures occur frequently. The skull may be involved in various ways and the appearance may not be unlike that of Paget's disease.

Two typical cases are described and illustrated with roentgenograms.—*Audrey G. Morgan.*

LINSMAN, JOSEPH, F., and MCMURRAY, CRAWFORD A. Fluoride osteosclerosis from drinking water. *Radiology*, May, 1943, *40*, 474–484.

It has long been known that an excess of fluoride in the drinking water causes mottled teeth but it has not been realized that osteosclerosis of the bones might be due to the same cause.

The authors describe a case in a white soldier twenty-two years of age who had grown up and lived for years in communities with excess of fluoride in the drinking water. He came for treatment for a chalazion of the right upper eyelid but examination June 18, 1942 showed a severe anemia. He had mottled tooth enamel; tests showed defective kidney function, and roentgen examination showed marked osteosclerosis of the bones, particularly those of the pelvis, spinal column, ribs and sternum. He died September 17 and autopsy showed chronic bilateral pyelonephrosis, bilateral hydroureter with ureteritis, acute cystitis, abscesses of the prostate, sclerosis of bones, dental fluorosis and hyperplasia of the bone marrow.

The great danger in fluoride osteosclerosis is that anemia will be caused by encroachment of the hardened bone on the marrow cavity. Unfortunately the sclerotic changes are most severe in the bones in which most of the blood is normally formed. Roentgenograms in these cases show considerable increase in density and coarsening of the trabecular patterns.

In the case described it is possible that chronic fluoremia may have aggravated kidney lesions that already existed or it may be that the osteosclerosis developed as a result of fluorine retention caused by the kidney lesions.

At any rate the existence of more than three parts of fluorine in a million parts of drinking water is a menace to public health and should be taken into account by public health authorities. Roentgen examinations of the skeleton should be made in all patients with dental fluorosis and anemia or defective kidney function in order to determine whether there is a fluoride osteosclerosis. A map of the United States is given showing the areas in which there is an excessive fluorine content in the water.—*Audrey G. Morgan.*

MACEY, HARRY B., and PHALEN, GEORGE S. Metastatic lesions of the sternum. *Surg., Gynec. & Obst.*, April, 1943, *76*, 453–455.

Tumors involving the sternum are not common. In the files of the Mayo Clinic there are 14 cases of neoplastic involvement of the sternum: 4 primary chondrosarcomas, 2 myeloblastic sarcomas, 1 endothelioma, and 7 metastatic tumors. Of the 7 metastatic tumors, 1 is from a carcinoma of the breast, 1 from a carcinoma of the thyroid, 1 from a caricnoma of the stomach, 1 from a carcinoma of the rectum, 1 from a hypernephroma, and 2 are from a possible primary pulmonary malignant lesion. These last 2 cases are reported by the authors

since no similar cases have been recorded in the literature.

The importance of taking roentgenograms of the sternum in all cases of sternal pain is stressed. If a destructive lesion of the sternum is seen in the roentgenogram, an adequate specimen for biopsy must be taken to determine, first, the benignancy or malignancy of the condition, and second, the feasibility of complete surgical extirpation.—*Mary Frances Vastine.*

Deery, Edwin M. Herniation of the nucleus pulposus as a complication of pre-existing low back instability. *Surg., Gynec. & Obst.*, July, 1943, *77*, 79–86.

In addition to uncomplicated herniation of the nucleus pulposus, this condition occurs as a complication of low back instability. A more general recognition of such combined problems than exists at present is needed. The diagnosis of herniated nucleus is discussed in some detail and this is the part of the study which is probably of most interest to the roentgenologist.

History. The history of herniated nucleus is that of pain along the course of the sciatic nerve. While the history is very characteristic it is of course not diagnostic. Pain along the front or lateral aspect of the leg is not sciatic pain. Sciatic pain is increased by all back movements and by coughing or sneezing. It may or may not be improved by bed rest. It is generally unrelieved or made worse by physiotherapy. It is considerably increased when the patient bends toward the side of the pain.

General Features. If the patient is seen in a severe attack of pain there is generally a protective limp and the back is bent forward. There is a flat low back from loss of the normal lumbar lordosis and the lumbar spine tends to curve away from the side of the pain.

Neurological Signs. 1. Motor signs. Muscle strength. The majority of these patients will show a little weakness in dorsiflexion of the foot on the affected side.

2. Muscle atrophy. Careful measurements made at 15 cm. above and below the patella of the affected leg will usually show slight atrophy. Atrophy of the gluteal muscle on the painful side is very often found.

3. Reflex changes. Almost all patients have a reduced to absent ankle jerk yet the location of the herniated nucleus is not always at the fourth-fifth lumbar interspace.

4. Sensory changes. Most of the patients will show characteristic sensory changes along the outer side of the lower leg and on the foot. The outer side of the lower leg as well as the outer side of the ankle and foot can be considered the area supplied by the first and second sacral nerves. If the sensory changes are limited to this area the herniated nucleus will generally be found at the lumbosacral interspace. If, in addition, there are sensory losses on the inner side of the foot, from toe to heel, which is the area supplied by the fifth lumbar, the nucleus will be found at the fourth-fifth lumbar interspace. Since the majority of herniations occur at the fourth-fifth lumbar interspace sensory changes will usually involve the fifth lumbar, first and second sacral skin areas.

Roentgen Findings. A narrowed intervertebral space is not a reliable guide to either the presence or the level of a herniated nucleus. The herniation can occur with a normal intervertebral space. In the group of cases with the herniated nucleus pulposus as a complication of a low back instability the orthopedic instability and narrowed intervertebral space were generally at the lumbosacral level whereas the herniated nucleus was usually found at the fourth-fifth lumbar interspace. Sensory testing was found to be the reliable guide to the level of the herniated nucleus regardless of the narrowed space.

Lipiodol. Lipiodol has not been used in the New York Orthopaedic Hospital and Dispensary for making the diagnosis of herniated nucleus as it has not been found necessary. A negative lipiodol study is not reliable proof of the absence of a herniated nucleus pulposus. Unless the surgeon is willing to operate upon the basis of real neurological signs, many patients with a negative lipiodol report will continue to have their herniated nucleus and the pain it produces.—*Mary Frances Vastine.*

Kelikian, H. Chronic arthritis. *Surg., Gynec. & Obst.*, April, 1943, *76*, 469–479.

Rheumatoid arthritis and osteoarthritis are compared under the following headings:

Synonyms.

Rheumatoid arthritis—atrophic, proliferative, infectious, inflammatory, etc.

Osteoarthritis—hypertrophic, degenerative, traumatic, senile, etc.

Etiologic Relations.

Rheumatoid arthritis—Under forty; pale asthenic women; foci of infection.

Osteoarthritis—Over forty; robust laborers; acute or chronic trauma.

Systemic reactions.

Rheumatoid arthritis—Fever; leukocytosis perhaps plus sedimentation rate.

Osteoarthritis—Absent.

Joints Predilected.

Rheumatoid arthritis—Those rich in primitive connective tissues—joints with extensive synovial membrane and bulbous articular ends, like the proximal interphalangeals.

Osteoarthritis—Weight-bearing, traumatized joints and those poor in circulation, like the distal interphalangeals.

Symptoms.

Rheumatoid arthritis—Pain and stiffness marked; many joints involved.

Osteoarthritis—Pain and stiffness relatively mild; one, or at most, a few joints affected.

Pathology.

Rheumatoid arthritis—

A. Primary: Inflammation of relatively primitive vascular connective tissues of the joint—of synovial membrane and bone marrow.
B. Secondary: Displacement or atrophy of specialized elements of the joint—of cartilage and bony trabeculae.

Osteoarthritis—

A. Primary: Wearing down of specialized elements of the joint—of cartilage and underlying bone.
B. Secondary Reactive process at the margins in the form of spurs.

Roentgen Findings.

Rheumatoid arthritis—Fusiform enlargement of soft part; disappearance of cartilage space along the margins; osteoporosis, subluxations, contractures, and ankylosis.

Osteoarthritis—Broadening of articular surfaces of bones; disappearance of the space in central areas and sclerosis of bone below; spurs, cystic areas, loose bodies.

Rationale of Treatment.

Rheumatoid arthritis—Regard the patient as a systemic disease and treat the patient as a whole.

Osteoarthritis—Direct attention to the joint itself; undertake measures to save it from wearing down.

Surgery.

Rheumatoid arthritis—Aim at putting a painful joint at rest (splintage), overcoming contractures (traction, turnbuckle splint, manipulation, capsulotomy, osteotomy, ostectomy, etc.); eradication of residual inflammation (synovectomy); mobilization of an already ankylosed joint (arthroplasty); and elimination of very painful one (arthrodesis).

Osteoarthritis—Indicated in presence of painful loose bodies (arthrotomy); when there are incongruities of surfaces that might beneficially be eliminated (erasion, arthroplasty); when there are chances of proffering a better weight-bearing surface (corrective osteotomy); when the joint has crumbled down and is painful (arthrodesis).—*Mary Frances Vastine.*

HARMON, PAUL H. Arthroplasty of the hip for osteoarthritis utilizing foreign-body cups of plastic. *Surg., Gynec. & Obst.*, March, 1943, *12*, 347–365.

Late results, approximately eighteen months following foreign body cup arthroplasty of the hip in osteoarthritis, utilizing a plastic methacrylate cup are reported in 13 cases (16 hips). The results have been excellent in 10 hips, or 62.5 per cent. The author discusses in some detail the alterations which occur in the osteoarthritic femoral head as well as the etiology and pathogenesis of osteoarthritis.

Gross and microscopic alterations of the osteoarthritic femoral head.

Early changes include;

1. Marginal osteophytes at the head-neck junction or at the lateral acetabular margin.
2. Widening of the head by growth of the adductor portion of the head.
3. Sclerosis within the head and above the acetabular articular bony cortex.
4. Cartilage space normal or slightly diminished.

Later changes include:

1. Spotty sclerosis appears in the head denoting osseous infarction or endosteal proliferation.
2. Marginal osteophytes increase in size.
3. The adductor portion of the head becomes disproportionate. In advanced cases the adductor osteophyte may be half as large as the head itself and may cause partial dislocation of the head.

4. Irregular islands of cartilage thinning occur. Cartilage is thrown up into pleat and ridge formation.

Etiology and pathogenesis of osteoarthritis.

The fundamental lesion in osteoarthritis or degenerative arthritis is the change that takes place in the articular cartilage. Whether osseous infarction occurs first or cartilage degeneration precedes it is immaterial as the end-result is the same, i.e., degeneration and fibrillation of cartilage and thickening and sclerosis of subchondral bone.

1. Thirty-seven of the 94 patients upon whom records were available at the Guthrie Clinic and the Robert Packer Hospital, Sayre, Pennsylvania, were assigned to the group of secondary osteoarthritis. The other 57 cases were classed as primary.

2. The mean age in the group of patients with primary osteoarthritis of the hip was sixty-four years while that of the secondary cases was forty-five years.

3. The incidence of osteoarthritic changes in other joints in the primary group was four times as common as in the group of secondary cases.

4. The disease was unilateral in all the secondary cases, except those following protrusio acetabuli, rheumatoid arthritis, Paget's disease, and slipped upper femoral epiphysis.

5. Obesity of a significant degree was present in one-third of the cases, and the body build in almost all the patients could be described as "large."

6. Foci of infection, generalized arteriosclerosis, cardiac disease, anemia, and increase in the blood sedimentation rate were encountered occasionally but not with a frequency that would implicate them as causative of the condition.

7. Save for the joint condition, the majority of these patients were in unusually good physical condition.—*Mary Frances Vastine.*

Houkom, S. Sverre. Tuberculosis of the ankle joint; end-result study of twenty-five cases. *Surg., Gynec. & Obst.*, April, 1943, *76*, 438–443.

At the New York Orthopaedic Hospital it has been the impression that the results of surgical fusion for tuberculosis of the ankle joint are uniformly good. In an attempt to secure a better evaluation of the end-results, a study was made of the 25 cases of tuberculosis of the ankle joint in patients treated from 1923 to 1938 inclusive.

Clinical Findings. (1) The age varied from fourteen months to forty-five years. The average age of onset was 13.5 years. (2) The usual presenting symptoms included; pain, swelling, fluctuation, increased local heat, muscle spasm, limitation of motion, equinus deformity, sinuses and a unilateral limp.

Diagnosis. (1) The roentgen findings are of considerable help in establishing the diagnosis, the important feature being a general decalcification of the bone with an associated well defined joint effusion. The presence of bone atrophy, thinning of the joint space, erosion of the articular cortex, and, in the more advanced cases, actual destruction of the bone are also helpful. (2) The sedimentation rate is elevated. (3) The Mantoux test is positive. (4) A positive diagnosis was established in all these cases by the pathologist.

Previous Treatment. The most common forms of treatment were incision and drainage of abscesses, leg casts, and braces.

Treatment. Immediate arthrodesis of a tuberculous joint is recommended at the New York Orthopaedic Hospital unless the general condition contraindicates it.

Pathology. (1) The joint capsule frequently bulges anteriorly and is thickened and edematous. (2) The synovial membrane is replaced by grayish yellow avascular friable granulation tissue. (3) The articular cartilage is often thin, lacking luster and is easily separated from the underlying bone. (4) Cavities in the adjacent bone of the talus or tibia are frequently present and filled with bone debris, caseation or granulation tissue.

Conclusion. (1) Arthrodesis is the treatment of choice for tuberculosis of the ankle and talocalcaneal joint regardless of age. (2) In younger patients with extensive bone destruction or in poor general condition, a preliminary rest period of four to six months may be advisable. (3) The average period of disability (1.2 years) when this form of treatment is used is much less than when a conservative regimen is followed. (4) Amputation is rarely if ever indicated in the treatment of tuberculosis of the ankle.—*Mary Frances Vastine.*

Lapidus, Paul W. Lesions of the inconstant sesamoids of the foot. *Radiology*, June, 1943, *40*, 581–585.

Five cases are described and illustrated with roentgenograms which show that the small and inconstant sesamoid bones of the foot may

cause severe pain and even disability. In a woman of thirty-three severe pain developed after stepping on a small, sharp pebble. After unsuccessful conservative treatment by padding for several weeks operation was performed and revealed fracture of the inconstant left second tibial sesamoid. An undivided sesamoid of the same size was found on the right side. Three cases of congenital bipartite sesamoids are described and 1 case of calcareous tendinitis of the tendons near the sesamoid of the left second toe. The patient in this case was a dancer who had severe pain beneath the ball of the left second toe. She had suffered no definite injury but had practiced dancing exercises several hours a day. Roentgenograms showed a normal well-formed sesamoid similar to the one on the opposite side except for several irregular calcareous deposits in the tendons around the bone. The sesamoid and the calcareous deposits were removed surgically and after three months the patient was able to resume dancing.—*Audrey G. Morgan.*

ROENTGEN AND RADIUM THERAPY

Crowell, Bowman C. The role of the cancer clinic in cancer control. *Radiology*, June, 1943, *40*, 539–542.

The author emphasizes the importance of cancer clinics in the general hospitals throughout the country, both for providing more adequate treatment for this disease and for giving instruction to the public so that cases may come for treatment earlier. There are now more than 380 clinics that conform to the minimum standard established by the American College of Surgeons. This standard requires that there shall be a definite organization of the service, including an executive officer and a representative of each of the departments of the hospital concerned in the diagnosis and treatment of cancer. There must be regular conferences or consultations at which the diagnosis and treatment of individual cases are discussed by all members of the clinic who are concerned with the case. There must be close cooperation between the departments of radiology, pathology, surgery and the surgical specialties. The author believes that cancer is still primarily a disease for surgical treatment but he recognizes the great contribution made by radiology to its control.

Though in the ten years since this movement was initiated there has been an increase in the number of five year cures of cancer, the annual cancer mortality is still increasing. At the present mortality rate a million and a half persons will die of cancer in the United States in the next ten years. The present preoccupation with the war should not be allowed to interfere with the cancer control program as cancer control is a measure for the conservation of man power.—*Audrey G. Morgan.*

Kress, Louis C., and Levin, Morton L. Experiences and results in tumor clinic organization in New York State. *Radiology*, June, 1943, *40*, 543–548.

In meeting the problem of cancer control the tumor clinic has long been a powerful weapon in upstate New York. A Commission was appointed in 1937 to study the cancer situation and make recommendations in regard to it. One of the chief recommendations was that encouragement be given to the establishment of cancer clinics in general hospitals. Legislation was enacted reorganizing the Division of Cancer Control and making cancer a reportable disease. It was believed that enough cancer clinics should be established so that no patient would have to travel more than 50 miles to reach one, for the shorter the distance the patient must travel, the greater the chances that a diagnosis can be made early. There are now 37 tumor clinics actively functioning in upstate New York. All but 4 per cent of the population are now within 30 miles of such a clinic. New York City is a separate administrative area as regards public health.

An especially important feature of the clinic work is that of following up the cases. Otherwise patients are lost from observation. There should be close cooperation between the Welfare Department and the clinic so that indigent patients may get adequate care. One of the promising developments in the furthering of the tumor clinic program has been the organization of a Tumor Clinic Association, composed of members of the staffs of the various tumor clinics and others elected to membership by the council. This organization is interested in every type of problem that confronts tumor clinics. It recently sponsored a Cancer Teaching Day held at the School of Medicine of Syracuse University and open to all physicians of the state.

The New York State program has stimulated the formation of new tumor clinics and improved the facilities available to those already established. It has fostered postgraduate edu-

cation in cancer. Facilities for the diagnosis and treatment of cancer have been brought within easier reach of the patient. Many hospitals are better equipped to cope with cancer than ever before. The object of the program, which must be kept up in spite of war time difficulties, is to make it possible for every cancer patient, rich or poor, to obtain prompt diagnosis and adequate treatment.—*Audrey G. Morgan.*

Wolfer, John A. The role of the surgeon in the tumor clinic. *Radiology*, June, 1943, *40*, 549–553.

The tumor clinic must have a competent team made up of radiologist, clinician, pathologist and surgeon and they must work in close cooperation. Greater emphasis must be placed in articles and textbooks on the early symptoms of cancer. Too often the symptoms described are such late ones that treatment is hopeless. The surgeon has an important place in diagnosis by means of exploratory operation. The public is being educated to the fact that many operations that might otherwise appear useless are quite important and necessary for the diagnosis of cancerous lesions.

There are three types of lesions that must be diagnosed, first the totally exposed ones, such as tumors of the skin, second the intermediate group in which the tumors can be seen through special instruments, such as the cystoscope, the esophagoscope and the gastroscope, and third, concealed lesions in which evidence can only be obtained by roentgen study, as in intrathoracic tumors, or tumors of the liver evidenced by jaundice.

The diagnosis once made the surgeon also has an important place in treatment. In order to make the operation as safe as possible for the patient he must be familiar with the methods of correcting dehydration, anemia, acid base balance, ion concentration, etc. He must also be able to recognize and differentiate between pathologic changes as he cannot always have a pathologist at hand.—*Audrey G. Morgan.*

Holmes, George W. A tumor clinic for patients of moderate means. *Radiology*, June, 1943, *40*, 554–556.

The author describes the tumor clinics that are now being established in general hospitals, and in addition a special clinic for patients of moderate means that has been instituted at the Massachusetts General Hospital. These patients are often less well served than either the very rich or the very poor.

The principles governing the already established tumor clinic were observed and the new clinic was made a part of the older one. These patients were able to pay a moderate fee. The free clinic is held in the morning and the pay clinic in the afternoon, using the same space and equipment and lay personnel, so that expenses are reduced. Only members of the staff of the free clinic were asked to serve in the pay clinic and it is administered by the same tumor clinic committee. The earnings from the clinic, after operating costs have been deducted, are divided among the professional personnel according to the number of hours spent in the clinic. If irradiation is advised the patient is referred to the department of radiology and if surgery is required he is referred to the surgical department and may choose his surgeon. All charges for treatment are made by the department (or physician) to which the patient is referred.

The clinic was established in June, 1942, and so far has made satisfactory progress. The charge per visit has not yet been definitely established but apparently it need not be more than ten dolllars for the first visit and five dollars for each subsequent visit. It is too early to draw any conclusions as to the value of the clinic but at least a beginning has been made in a new field.—*Audrey G. Morgan.*

Uhlmann, Erich, Practical aspects of tumor clinic management. *Radiology*, June, 1943, *40*, 557–564.

The author discusses the management of the tumor clinic in the Michael Reese Hospital in Chicago. Representatives from the different departments—Surgery, Gynecology, Dermatology, Eye, Ear, Nose and Throat, etc.,—are selected for consultants on the staff. They must be of associate rank or higher to insure that they will have had the necessary experience and it must be known that they have a special interest in the diagnosis and treatment of cancers in their own field. They must agree to attend the group consultations so as to become familiar with the cases under consideration. Each year four men are replaced so that there are always a certain number of men on the staff who have had experience in tumor clinic management.

In addition to the regular consultations monthly conferences are held in which particularly interesting cases are discussed—surgical

cases are presented to the surgical group, gynecological cases to the gynecological group, etc.

One of the difficult problems is the selection of a chairman for the group. Much of the success of the clinic depends on the chief. He may be a pathologist, surgeon or radiotherapist, though the author is inclined to favor the selection of a radiotherapist. The diagnostic roentgen department should be kept separate from the radiotherapeutic department. Every patient admitted to the hospital with a diagnosis of tumor must be referred to the Tumor Clinic before any treatment is given. If the referring physician or surgeon does not agree with their decision, the final decision is made by the representative in the Tumor Clinic of the department concerned. So far there has not been any special difficulty in settling differences of this kind. A fine spirit of cooperation has been shown in the Michael Reese Clinic.—*Audrey G. Morgan.*

JERRAM, C. W. S., and LANGMEAD, W. A. A method of treatment for carcinoma of breast including the forequarter. *Brit. J. Radiol.*, Jan., 1943, *15*, 26–29.

A method of treating carcinoma of the breast and the adjacent tissues as a single unit is described. Treatment is given through five fields arranged around the forequarter (pectoral region, axilla and scapula) regularly as the five sides of a pentagon with the roentgen-ray beam so arranged that the volume of tissue irradiated is a five-sided pyramid whose floor is a plane surface from sternum to scapula, thus avoiding lung tissue, and whose apex lies lateral to the head of the humerus. The tissue in the pyramid is treated with nearly a uniform dosage. It is possible to give a larger total dose in a reasonable over-all time because five fields are used and because the method avoids deeper structures. For this same reason the lung is not damaged. The method is a standard one which can be reproduced at any time and gives identical cases for comparison of results.

Illustrations of the application of the method are given, a diagram showing how the fields are tilted to avoid lung tissue and the isodose curves for pentagonal distribution. A dose of about 3,000 r can be given throughout the forequarter in four weeks without general disturbance or severe skin injury.—*Audrey G. Morgan.*

DE CHOLNOKY, TIBOR. Mammary cancer in youth. *Surg., Gynec. & Obst.*, July, 1943, *77*, 55–60.

Seventy-three cases of mammary cancer in patients under thirty years of age are reviewed and the following conclusions are reached:

1. Cancer of the breast in patients under thirty years of age accounts for 2 per cent of all mammary cancers.

2. Early diagnosis can be made with certainty only in the laboratory.

3. In small tumors less than 2 cm. in diameter, lymph nodes are infrequently involved and the prognosis is favorable.

4. Five year survivals in the patients operated upon were found to be 40.8 per cent; ten year survivals, 37 per cent.

5. The results of radical surgery in young women under thirty years of age are comparable to those obtained in the more advanced age groups.

6. The previously held belief that the prognosis for women under thirty years of age who have malignant tumors of the breast is fatal seems untenable.—*Mary Frances Vastine.*

NUTTALL, JOHN R. The intra-oral radium treatment of cancer of the mouth. *Brit. J. Radiol.*, Feb., 1943, *96*, 45–48; March, 72–81.

A very high percentage of malignant tumors in the mouth are squamous cell carcinomas and with these tumors there is only a slight margin of safety between the tumor lethal dose and the dose that causes necrosis of normal tissue. Dosage therefore must be very accurate. The system of Paterson and Parker is a simple method of giving accurate dosage.

Modern treatment of cancer of the mouth is by radium, and dosage should be reported in international roentgens. The total number of roentgens and the overall time should be given. The optimum overall time is from seven to ten days and in this time 6,000 to 8,000 r can be given safely. For successful treatment the volume irradiated must be as small as is consistent with irradiating the whole tumor. Only one treatment is possible for squamous carcinoma and the tolerance dose must be given. If the case is curable a larger dose must be given than that necessary for palliative treatment. It is difficult to determine the boundary between curable and palliative cases and ideas on the subject change with improving technique. The best method of treating epitheliomatous glands is by block dissection. If this is impossible on account of the patient's condition, extensive treatment of the mouth cancer is not worth while.

In general, probably external mould treat-

ment is preferable to implantation of needles. This depends to some extent on the site of the tumor, and a table is given showing the preferable treatment according to site.

Biopsy is valuable in diagnosis and not dangerous. Carcinoma and syphilis frequently coexist but it is not worth while delaying treatment of the cancer to treat the syphilis as antisyphilitic drugs cause deterioration of the general condition below the limits of safety for operation.

Decayed teeth should be removed before treatment but the removal of carious teeth from irradiated tissue is dangerous and the dentist should be informed if there are any irradiated areas in the mouth when he undertakes an extraction.

A table is given showing the results of treatment in this series. Among 442 patients with cancer of the mouth of all stages treated by radium 28 per cent survived for five years. Among 140 cases in which the glands had not become involved 65 per cent survived five years or more.

Intraoral cancers may be treated by means of dental moulds or by implantation of needles. Moulds may be made of vulcanite or dental impression compound. Detailed descriptions are given of the application of moulds and the implantation of needles for tumors at different sites and illustrative roentgenograms are given.

Good anesthesia is of great importance in the implantation of needles and decreases the risk of bronchopneumonia. Adequate anesthesia can generally be maintained by the endotracheal administration of nitrous oxide and oxygen. Sodium evipan can be used if general anesthesia is contraindicated. Careful nursing is also of the greatest importance in preventing lung complications. Radon seeds are particularly useful in the treatment of small lesions in the aged or frail as they can be inserted under local or regional anesthesia. The needles can generally be removed after seven to ten days' treatment without anesthesia.

As a rule, mould techniques with moderate doses cause less damage to the tissues than implantation of needles. The safest end appearance is a slight pale atrophy which is pliable and free of marked telangiectasis. This follows a treatment of 6,500 r given in seven days to fields of medium size.—*Audrey G. Morgan.*

Nolan, James F., and Quimby, Edith H. Dosage calculations for various combinations of parametrial needles and intracervical tandems. *Radiology*, April, 1943, *40*, 391–402.

The application of radium by the use of interstitial parametrial needles in combination with intracervical tandems has been recommended in recent years because it gives a wider distribution of radium in the pelvis and avoids the danger of necrosis from overdosage.

A number of arrangements of the needles and tandems have been used by different workers and the authors make a study of the distribution of the radiation in each one as influenced by such factors as variations in the lateral position of the needles, variations in the angulation of the needles and variations in exposure time. Of course in this work it was necessary to assume exact placing and angulation of the needles, which is not always possible in practice.

Diagrams of the various types of arrangement are given and for each type diagrams of the region to be irradiated with isodose curves in gamma roentgens. A wealth of detail is given with regard to the distribution of the radiation by these different methods but it seems that none of them is adequate for the treatment of pelvic lymph node involvement. The object of this work, however, was not to establish a definite plan of treatment but to work out the factors which influence the distribution of radiation and the ways in which they affect it so that still better plans for treatment may be devised.—*Audrey G. Morgan.*

Skinner, Edward Holman. An introduction to the history of carcinoma of the cervix uteri. *Radiology*, May, 1943, *40*, 433–435.

The author gives a brief review of the history of carcinoma of the cervix, beginning with the Egyptian and Hippocratic era of empiricism from the earliest times to 1761 A.D. and continuing through the era of description and classification from 1761 to 1900 and that of experimental study beginning in 1900.

In 1761 Morgagni described the autopsy findings in cancer of the uterus. Peyrilhe in 1776 gave the first suggestion of extension by way of the lymphatics. Langenbeck performed one of the first vaginal hysterectomies in 1813, based on a prize-winning essay by Wrisberg in 1810. Wagner's Gebärmutterkrebs (cancer of the uterus) in 1858 described the metastatic pathways though he believed that the disease originated in connective tissue as well as epithelium. Virchow echoed this opinion in his

Cellular Pathology and Thiersch in 1865 first proved the epithelial origin of carcinoma. During this period of about one hundred years there is a history of vaginal hysterectomy. Freund described the principles of abdominal hysterectomy in 1878 but the high mortality from this method led to resolutions of condemnation by medical societies. The work of Howard Kelly and Wertheim in abdominal hysterectomy is mentioned and Wertheim's method pronounced too difficult for general use.

Irradiation was foreshadowed by Fouveau de Courmelles in 1904 when he checked menopausal bleeding by irradiation. The further progress of irradiation up to the present time is briefly reviewed and the suggestion made that vaginal hysterectomy still has a place in the treatment of carcinoma of the cervix.—*Audrey G. Morgan.*

SCHEFFEY, LEWIS C. Experiences in the treatment of carcinoma of the cervix uteri. *Radiology*, May, 1943, *40*, 436–446.

The author analyzes a group of 310 patients with carcinoma of the cervix of the uterus seen on the Gynecological Ward Service of Jefferson Medical College Hospital in Philadelphia in the past sixteen years. Tables are given showing the details of the results. He speaks of five year salvage rather than five year cure because survival for five years does not by any means insure cure. He has seen recurrences as long as ten years after treatment.

Of the 310 patients seen 293 were treated. The absolute salvage rate at the time of this report was 14.3 per cent. The absolute rate means the percentage of patients seen, the relative rate the percentage of patients treated. The relative five year salvage rate including deceased patients who lived five years or longer after treatment was 23.8 per cent.

Surgery was used in the treatment of only 8 cases and surgery alone was not used in any case. From 1921 to 1931 radium was used most frequently, generally in the form of a single treatment. During this time external roentgen irradiation was used occasionally, generally after the use of radium, and most commonly in cases of recurrence. From 1931 to 1934 roentgen irradiation was used more frequently after radium, and in far advanced cases without radium. In 1934 and 1935 the use of external roentgen irradiation before radium treatment was begun. This method has proved its value. The technique of the different methods used is described.

Catharine McFarlane and her co-workers have shown that much can be accomplished by routine pelvic examination and frequent biopsies.—*Audrey G. Morgan.*

SANTE, L. R. Further experience with pneumoperitoneum as an aid in pelvic irradiation. *Radiology*, May, 1943, *40*, 447–453.

There is no doubt that larger doses of radiation should be used in the treatment of cancer of the pelvis. But there is danger of injuring the intestinal mucosa which is extremely sensitive to the action of rays. This difficulty can be obviated by placing the patient in the Trendelenburg position and introducing into the peritoneal cavity a slightly larger amount of air than that used in diagnostic pneumoperitoneum. This pushes the intestines up beyond the action of the rays. Diagrams are given showing the location of the portals and instructions given for determining the optimum direction of the roentgen-ray beam in each case. Slight compression materially increases the depth dose.

The author has used both 50 and 80 cm. distances. With 200 kv., 18 ma., 1 mm. copper effective and 1 mm. aluminum filter, half-value layer of 1.46 mm. copper, 49 r per minute is given until a dose of 200 r, measured in air, is applied to all four anterior fields and one lateral field one day. The next day the four posterior fields and the other lateral field are treated in the same way. Treatment is continued until a pronounced skin reaction occurs, which usually ends in desquamation.

The use of pneumoperitoneum for increasing the amount of radiation that can be applied to the parametrium is independent of the method used in treating the cervical lesion, whether by radium or roentgen rays given with an intravaginal cone.

Not enough patients have been treated in this way and the time since treatment was begun is too short for its value to be estimated.—*Audrey G. Morgan.*